Engineering Library

NOV 25 1927

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLIV.—No. 3748] LONDON: FRIDAY EVENING, NOVEMBER 11, 1927 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

X-Rays and the Crystalline Structure of Materials.
(SIR W. BRAGG.) THE ENGINEER, 11 - 11 - 27.

An American Diary—No. XVI.
THE ENGINEER, 11 - 11 - 27.

River Rother Improvement Works.
THE ENGINEER, 11 - 11 - 27.

The Ferrybridge Electric Power Station No. III.
THE ENGINEER, 11 - 11 - 27.

A 6-Cylinder Motor Omnibus.
THE ENGINEER, 11 - 11 - 27.

The Motor Vessel Itapé.
THE ENGINEER, 11 - 11 - 27.

Mining Congress in Canada.
THE ENGINEER, 11 - 11 - 27.

Extensions to Stoke-on-Trent Generating Station.
THE ENGINEER, 11 - 11 - 27.

Constant-Radius Luffing Crane.
THE ENGINEER, 11 - 11 - 27.

INDEX TO ADVERTISEMENTS, PAGE 99.

PUBLIC NOTICES

R.A. 2522.

Ministry of Transport.
ARTERIAL ROADS, GREATER LONDON.
NORTH CIRCULAR ROAD—WALTHAMSTOW.
EPPING FOREST SECTION.

The Minister is prepared to receive TENDERS for CONSTRUCTIONAL, SURFACING and OUTFALL DRAINAGE WORK in connection with the Epping Forest Section of the North Circular Arterial Road, Walthamstow, Essex.

Form of Tender, conditions of Tender, conditions of contract, bill of quantities and specification may be obtained from the Chief Engineer, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, upon payment of a deposit of £25.

This amount will be returned to the tenderer if his Tender is a bona fide one and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

The drawings may be inspected at the offices of the Ministry, and copies of the Tender documents will be available on and after Friday, 25th November, 1927.

Tenders on the official form, accompanied by a fully priced bill of quantities and schedules of prices, and enclosed in a sealed envelope, endorsed "Tender for Construction and Surfacing, North Circular Road, Essex," must reach the Assistant Secretary, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, by 10 a.m. on Friday, the 9th December, 1927.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this 7th day of November, 1927.

H. H. PIGGOTT,
Assistant Secretary.
6955

The Director-General,
India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. 194 PAIRS WHEELS and AXLES for CARRIAGES.
2. 33 SETS of BODY FITTINGS, &c., for ROLLING STOCK.
3. 462,000 CAST IRON SLEEPER PLATES.
4. 231,000 TIE BARS.
5. 308,000 GIBS and 616,000 COTTERS.
6. 616,000 KEYS.

Tenders due on the 2nd December, 1927, for Nos. 1 and 2, and on the 5th January, 1928, for Nos. 3 to 6.

Forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 7007

Assistant Engineers (5)
REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance.

Subject to satisfactory service the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 35 years of age, must have passed the examination for A.M.I.C.E., or possess a degree in Civil Engineering recognised by the Institution as exempting from parts "A" and "B" of the examination. Must have had proper technical training and preferably have had not less than two years' subsequent experience on large Engineering or Municipal works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/254. 6989

State Electricity Commission
OF VICTORIA, AUSTRALIA.

TENDERS are hereby INVITED for the MANUFACTURE, SUPPLY, and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, of GABLE BOTTOM 20-TON COAL TRUCKS for 90 c.m. railway, in accordance with Specification No. 28/1.

Copies of Tender form, specification, &c., will be available upon application to :—
The Agent-General for Victoria,
Victoria House,
The Strand, London, England.

CHARGE.—£1 for three copies of Tender form, conditions of contract and specification complete. This charge will be returned in the event of a bona fide Tender being received. Extra copies 5s. each, not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is to be lodged at the office of the Agent-General for Victoria.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered at the office of the Commission, Melbourne, not later than 5 p.m. on 16th January, 1928.

The Commission does not bind itself to accept the lowest or any Tender.

W. J. PRICE,
Acting Secretary.
6966

DRY DOCKING, &c., OF R.A.S. "GENEVA CROSS."

The Metropolitan Asylums
BOARD invite TENDERS for DRY DOCKING and REPAIRING the HULL and FITTINGS of the River Ambulance Steamer "Geneva Cross."

Specification, conditions of contract and form of Tender may be obtained at the office of the Board, Victoria Embankment, E.C. 4.

Tenders, addressed as noted on the form of Tender, must be delivered at the office of the Board not later than 10 a.m. on Wednesday, 30th November, 1927.

ALLAN POWELL,
Clerk to the Board.
6963

Karachi Port Trust.
APPLICATIONS are INVITED by the Trustees of the Port of Karachi for the POST of SUPERINTENDENT of MACHINERY.

Applicants must have served a full apprenticeship in some recognised Engineering and Shipbuilding Works and must hold a First Class Engineer's Board of Trade or Colonial Certificate. Age should be about 35 years.

Applicants must have had extensive experience in ship construction and repair, and general dockyard work, and also in the working and maintenance of dredgers, tugs, floating craft, and port equipment.

The salary is Rs. 900-50-1100 per mensem, with free quarters.

The successful applicant will be on probation for six months. If confirmed, he will be required to enter into a five years' agreement, which will include the six months' probationary period.

He will have to conform to all Port Trust Rules and to contribute to the Provident Fund.

A first-class free passage to India will be provided, with a return passage home on satisfactory termination of services.

Applications, with references and copies (which will not be returned) of testimonials, and stating age, parentage, nationality, and giving particulars of training and experience, will be received by the undersigned not later than 18th November, 1927.

RENDEL, PALMER & TRITTON,
12-15, Dartmouth-street, London, S.W. 1.
6873

PUBLIC NOTICES

Bombay, Baroda and Central
INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Thursday, 24th November, TENDERS for the SUPPLY of :—
1. COPPER RODS and TUBES.
2. SPRING STEEL.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
8th November, 1927. 6992

City of Leeds.
WATERWORKS DEPARTMENT.

The Waterworks Committee of the Leeds City Council invite DESIGNS (where stipulated) and TENDERS for the WORKS set out hereunder :—
CONTRACT NO. 238.
DESIGN and TENDER for a WATER-TIGHT REINFORCED CONCRETE RESERVOIR (capacity 1½ million gallons) at Middleton, in the City of Leeds.
CONTRACT NO. 239.
DESIGN and TENDER for a WATER-TIGHT REINFORCED CONCRETE ELEVATED TANK (capacity 100,000 gallons) at Tinshill, in the City of Leeds.
Also TENDER for the CONSTRUCTION of a WATER-TIGHT MASS CONCRETE SERVICE RESERVOIR at the same place (capacity 1 million gallons), including DESIGN and TENDER for the REINFORCED CONCRETE ROOF and PIERS (only) for same.

Copies of the conditions of contract (including specification and form of Tender, &c.) may be obtained on application to the Waterworks Department, 26, Great George-street, Leeds, on payment of a deposit of One Guinea for each, or either, of the two sets of contract documents and prints of general plans, which deposit or deposits will be returned on receipt of a bona fide Tender or Tenders. Other plans of the works can be inspected at the Waterworks Department.

Designs and Tenders, under sealed covers, endorsed and addressed as shown in the conditions of contract, to be delivered to the office of the Town Clerk, Great George-street, Leeds, not later than 10 a.m. on the 12th December, 1927.

The Waterworks Committee does not bind itself to accept the lowest or any Tender.

HARRY SHORTREED,
Waterworks Manager.
28th October, 1927. 6990

PUBLIC NOTICES

Torquay Corporation Waterworks.
FERNWORTHY PIPE LINE.

The Corporation of Torquay invite TENDERS for the SUPPLY and DELIVERY of 16in. BITUMENLINED LAP-WELDED STEEL TUBES.

Specification and form of Tender can be obtained from the Water Engineer, M. S. C. Chapman, M. Inst. C.E., upon the payment of a deposit of Two Guineas, which will be refunded upon the receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted.

HERBERT A. HIELD, M.A.,
Town Clerk.

Town Hall, Torquay,
November, 1927. 6962

TO SEWERAGE WORKS CONTRACTORS.

Windsor Rural District
COUNCIL, BERKS.
SUNNINGHILL AND SUNNINGDALE MAIN SEWERAGE.
EXTENSIONS.
CONTRACT "H."

The Windsor Rural District Council invite TENDERS from contractors experienced in sewerage works for the CONSTRUCTION of about THREE MILES of 6in., 7in., 8in., 9in., and 12in. STONEWARE and CAST IRON PIPE SEWERS, with MANHOLES and other WORKS incidental thereto, in the Parishes of Sunninghill and Sunningdale.

Plans and specification may be inspected at the office of Messrs. Lemon and Blizard, 9, Victoria-street, Westminster, the Engineers for the works, on and after the 21st day of November, 1927, between 10 a.m. and 5 p.m.

Bills of quantities, specification, conditions of contract and form of Tender may be obtained from the Engineers upon the payment of Five Guineas by cheque, which will be returned on the receipt of a bona fide Tender and the return of all documents lent, excepting the bills of quantities.

Tenders, upon the forms supplied, enclosed in a sealed envelope addressed to me, must be delivered at my office not later than Noon of Monday, December 5th, 1927.

The Council do not bind themselves to accept the lowest or any Tender, and the acceptance of any Tender received is subject to the approval of the Ministry of Health.

J. E. GALE,
Clerk to the Council.
18, Sheet-street, Windsor, Berks.
November, 1927. 6997

PUBLIC NOTICES

South Indian Railway Company,
LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. STEEL RAILS and FISH-PLATES (approx. 13,000 Tons).
2. COPPER RODS, TUBES and INGOTS, and BRASS SHEETS, &c.
3. BOLTS, NUTS, RIVETS, &c.
4. STEEL TYRES for LOCOMOTIVE ENGINES and TENDERS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Rails and Fish-plates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 25th November, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specifications Nos. 3 and 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1,
9th November, 1927. 7004

Urban District Council of
NEWRY.
NOTICE TO BRIDGE BUILDERS.
TENDERS FOR NEW STEEL SWING BRIDGE.

The Urban District Council of Newry invite TENDERS for the CONSTRUCTION of a NEW SINGLE-LEAF STEEL SWING BRIDGE over the canal at Godfrey Bridge, Newry. Full particulars regarding design, alterations and additions to abutments and plan of site can be obtained from Mr. C. Blaney, Town Surveyor, Town Hall, Newry, on payment of the sum of £1 1s., which will be refunded to contractors who submit a bona fide Tender.

The price and all other things being equal, a preference shall be given to contractors employing exclusively trades union labour under trades union conditions and also to those undertaking to employ local fitters in the erection of the bridge at the site.

Contractors will be required to provide at their own expense a bond from an approved Insurance Company or Guarantee Society for the due fulfilment of the contract, and a letter must accompany the Tender from the Insurance Society or Company proposed undertaking to supply the required bond.

The Council desire that the contract for the construction and erection of the bridge should be completed on or before 31st March, 1928, and contractors shall state in their Tenders if they are prepared to undertake same.

Designs and specifications should be delivered to the Town Surveyor on or before 7th December next, and sealed Tenders addressed to the Chairman, Urban District Council, Town Hall, Newry, and endorsed "Tender for Steel Swing Bridge," will be received up to the 10th December, 1927.

The Council shall have the right to accept any Tender provisionally subject to the approval of the Ministry of Home Affairs, N.I.

The Council shall not be bound to accept the lowest or any Tender.

Dated this 8th day of November, 1927.

By Order,
W. M. CRONIN,
Town Clerk.

Council Offices,
Town Hall, Newry. 6993

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

LARGE INDUSTRIAL COMPANY REQUIRES IMMEDIATELY for its Electrical Engineering Department a number of fully qualified DRAUGHTSMEN, with previous experience with Industrial or Municipal Electricity Undertakings in Power Station Extensions, Distribution Systems, Sub-stations, Transformers, Switchgear, Motors, Automatic Control, &c. Must be capable of conducting their own correspondence.

Address, in first instance, not later than the 17th inst., stating age, present post, and salary required, 6970, The Engineer Office. 6970 A

WANTED, an Experienced SURVEYOR for Land Surveys involving levelling in rough country, North Midlands. State salary required, age, and experience. A knowledge of civil engineering and experience abroad desirable.—Address, 6957, The Engineer Office. 6957 A

WANTED, ASSISTANT WORKS MANAGER for a progressive works. Must be very energetic and a good organiser and capable of handling men; 7.30 a.m. man.—Apply by letter only, giving full particulars as to age, experience, to whom reference can be made, and salary required, to J. and H. McLAREN, Ltd., Midland Engine Works, Leeds. 6998 A

SITUATIONS OPEN (continued) Page 2.
SITUATIONS WANTED, Page 2.
AUCTIONS, Page 100.
PARTNERSHIPS, Page 2.
EDUCATIONAL, Page 2.
MACHINERY, &c., WANTED, Page 100.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.
FOR HIRE, Page 100.
PUBLICATIONS, Page 100.
FOR SALE, Pages 2, 3 and 4.
PATENTS, Page 2.
BUSINESSES and PREMISES (For Sale, etc.), Page 100.
WORK WANTED, Page 6.

For Advertisement Rates see Leader Page.

SITUATIONS OPEN (continued)

WANTED, ENGINEERING SALESMAN, Knowledge of Steam Plant, including Condensers, Reciprocating and Rotary Pumps, essential. Age 30-40. Good salary and commission with excellent prospects for energetic man.—Address, with full particulars, P3879, The Engineer Office. P3879 A

WANTED, to Fill a Vacancy Caused by the Death of one of the directors, a thoroughly qualified and keen MAN of BUSINESS to take an active share as DIRECTOR in an old-established firm of Heating Engineers and Horticultural Builders in the Midlands. Full-time occupation with good remuneration. Only those who are prepared to take an active part and have had practical experience in Central Heating and Building Construction and the preparation of estimates will be considered. Applicant receiving appointment will be required to purchase an agreed number of shares. State age, experience, and give references.—Address, 6988, The Engineer Office. 6988 A

ASSISTANT to WORKS MANAGER WANTED by Engineering Firm on N.E. Coast engaged on constructional work, principally Gasworks Plant, Oil Installations and General Engineering. Smart young man with sound knowledge of engineering to act as Assistant to Works Manager.—Address, stating age, experience, and salary required, 6980, The Engineer Office. 6980 A

ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., REQUIRE ENGINEER EXPORT MANAGER; previous experience Machine Tools and Foreign Markets essential. Knowledge of foreign languages advantageous.—Apply, with full particulars, stating salary required, to GENERAL MANAGER, 17, Grosvenor-gardens, S.W. 1. 6987 A

BLAST-FURNACE MANAGER REQUIRED. Must be competent, practical man used to control of Hematite Blast-furnaces, with a thorough grasp of the process, and used to handling men.—Apply, with full particulars as to age, qualifications, experience, and salary required, to SECRETARY, Consett Iron Co., Ltd., Consett, Co. Durham. 6964 A

BLAST-FURNACES.—WANTED, ASSISTANT to MANAGER. Young man with good engineering training preferred.—Address, giving full details and salary required, 6989, The Engineer Office. 6989 A

CIVIL ENGINEER REQUIRED, Experienced in Laying Out Lines and Levels for a large Constructional Contract. Should be capable of measuring up quantities and checking details in Ferro-concrete, Brick and Steel Structure. State age and salary.—Address, 7003, The Engineer Office. 7003 A

ENGINEER SURVEYOR REQUIRED by an Insurance Company; must possess a First Class or preferably an Extra First Class Certificate of the Board of Trade; a sound general and technical education essential. Commencing salary £270 per annum.—Address, P3882, The Engineer Office. P3882 A

ENGINEER, Unmarried, Age 25-30, REQUIRED for large Plantation Company in Dutch East Indies; 1st class thoroughly practical experience Gas and Oil Engines (erection and maintenance) and of Constructional Work essential; also experience of Electrical Machinery. Commencing salary £600 per annum and, if satisfactory, participation in profit-sharing scheme after first year. Free passage, bungalow accommodation, periodical full-pay furlough, and medical attendance.—Write, with copies of testimonials and recent photograph, to Box 332, c/o Judd's, 47, Gresham-street, London, E.C. 2. 6996 A

REINFORCED CONCRETE ENGINEERS.—REQUIRED IMMEDIATELY by Specialist Reinforced Concrete Engineers in South Africa, ENGINEER experienced in all branches Reinforced Concrete Design and Construction, aged 25 to 28. Salary to commence £35 to £40 monthly. Also JUNIOR ENGINEER, age about 21, similar experience to above. Salary to commence about £25 monthly. Passage paid, three years' agreement.—Applicants should write, giving full details experience and references, to Box 806, Frost-Smith Advg. Service, 66, Finsbury-pavement, E.C. 2. P3877 A

REPRESENTATIVES WANTED for Complete Range of Abrasives, comprising Wheels, &c., Cloths, Papers, Grains, Powders, and Waterproof Papers. Applications invited from salesmen competent to ensure large business where quality, experience, and supply are right. State experience, area covered, and terms.—Address, P3881, The Engineer Office. P3881 A

TECHNICAL REPRESENTATIVE, with Commercial experience, REQUIRED, having intimate knowledge of modern British and American Machine Tools.—Apply by letter only, stating experience, age, and salary required, to CHARLES CHURCHILL and CO., Ltd., Albion-street, Gaythorn, Manchester. P3872 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the SERVICES of an experienced RATE FIXER for Pattern, Moulding, and Machine Shop Departments. Experienced in the Rowan system preferred.—Apply in writing, giving age and full particulars of experience, to the FOUNDRY GENERAL MANAGER. 6967 A

WORKS MANAGER or SUPERINTENDENT for Electrical Factory manufacturing Switchgear and Radio Components. Keen capable man of proved ability, tactful disciplinarian, qualified in modern manufacturing methods of tooling, machining, assembling and finishing.—Write full details experience, salary, Box 590, Sells, Fleet-street, E.C. 4. 6975 A

WANTED, DRAUGHTSMAN, with First-class knowledge of Chemical and By-Product Recovery installations; also familiar with Artificial Silk machinery. State wage and salary required.—Address, 6925, The Engineer Office. 6925 A

WANTED for Works Extension on N.E. Coast, DRAUGHTSMAN, with first-class experience in the Lay-out and Design of the following:—
(A) Modern Coke Oven and By-products Plants.
(B) Water Gas and Producer Gas Installations.
(C) Modern Boiler Plants.
(D) Material Handling and Storage Installations.
(E) Chemical Plants.
(F) General Works Plant.
Salary according to qualifications. Only experienced men under 35 years of age need apply.—Address, 6961, The Engineer Office. 6961 A

WANTED, Good DRAUGHTSMAN, Thoroughly experienced in design of Screw and Hydraulic Jacks, Blocks, Winches, &c. Application treated confidentially. — Address, "CONFIDENTIAL," Tangyes Limited, Cornwall Works, Birmingham. 7000 A

WANTED, London District, Experienced DRAUGHTSMAN, capable of designing and estimating for Elevators and Conveyors and General Plant Lay-out.—Address, giving full particulars, P3880, The Engineer Office. P3880 A

ASSISTANT DRAUGHTSMAN WANTED, Accustomed to Lancashire Boiler and Pipe Work.—H. and T. DANKS (NETHERTON), Ltd., Netherton, Dudley. 7009 A

DRAUGHTSMAN for Works in London Area; Refrigerating experience essential. Must be well versed in modern production methods, jigs and tools.—Write, stating age, experience, and salary required, to Box 606, Sells' Advertising Offices, Fleet-street, E.C. 4. 7005 A

DRAUGHTSMAN.—WANTED, Experienced DRAUGHTSMAN for design of Special Automatic Mechanisms; age 26 to 30.—Address, stating age, experience, and salary required, 6985, The Engineer Office. 6985 A

DRAUGHTSMAN WANTED by Large Company in Canada, one having necessary actual experience, to Design a Complete Line of Air Compressors of the Vertical High-speed Type, and also with some operating experience. Preferably Scotch, with technical education and not over 35 years of age. Situation permanent if applicant satisfactory.—Address, giving full particulars of experience, &c., 6982, The Engineer Office. 6982 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN, Experienced in Measuring and designing Light Steel Structures, Iron Staircases, &c.—Write, stating age, experience, salary, Box 612, Sell's, Fleet-street, E.C. 4. 7010 A

JUNIOR DRAUGHTSMAN REQUIRED, Who Has had workshop experience in the Production and Tool-room Departments.—Address, stating experience, age, and wages required, 6969, The Engineer Office. 6969 A

PROMINENT MOTOR CAR MANUFACTURERS REQUIRE TWO SENIOR DRAUGHTSMEN.—Write, stating age, experience, salary required, to Box 589, Sell's Advertising Offices, Fleet-street, E.C. 4. 6974 A

YOUNG DRAUGHTSMAN WANTED, with workshop experience, age 25 to 30, for Calcutta office of Waterworks Engineers and Contractors. Salary 500 Rupees per month, with yearly increments of 50 R. per month. Five years' engagement. Situation offers good ultimate prospects for suitable man.—Address, giving particulars of age, engineering and drawing-office experience, &c., 6978, The Engineer Office. 6978 A

YOUNG MECHANICAL DRAUGHTSMAN REQUIRED by Firm in the Midlands specialising in Combustion Engineering.—Address, stating age, salary required, experience, 6999, The Engineer Office. 6999 A

AN ASSISTANT FOREMAN is REQUIRED for the Painting and Packing Department of an Engineering Firm in East Anglia.
Applicants should be from 25 to 35 years of age, and must have had previous experience of packing and despatch of machinery for home and export.
Full particulars of career, age, and salary required are to be stated.
Address, 6981, The Engineer Office. 6981 A

FOREMAN WANTED for Brassfinishing Shop, Midland Manufacturers of High-class Steam Fittings. Must be good disciplinarian and thoroughly up to date. State experience, salary, &c.—Address, 6956, The Engineer Office. 6956 A

SITUATIONS WANTED

A COMMERCIAL ENGINEER, Having Drawing-office, works and sales experience, REQUIRES EMPLOYMENT as London Representative.—Address, P3867, The Engineer Office. P3867 B

AS RESIDENT ENGINEER on Heavy Bridge, Dock or Railway Work. Highest references.—Address, P3862, The Engineer Office. P3862 B

CENTRAL EUROPE.—SITUATION REQUIRED as REPRESENTATIVE of an INDUSTRIAL CONCERN. Certificated technical engineer for general engineering and naval constructional expert with all-round education (head engineer and adviser on political economy to a government for foreign trade and commercial politics); 15 years of practice, world-travelled, 39 years of age, ready to undertake organisation of a commercial engineering office on the Continent; international experience, bank guarantee.
Address, P3883, The Engineer Office. P3883 B

CIVIL ENGINEER (26), University Graduate, Eight years' wide experience, including gas and water engineering, electric supply works, buildings, reinforced concrete steel work, &c.; good business training, SEEKS APPOINTMENT at home or abroad.—Address, P3884, The Engineer Office. P3884 B

CIVIL ENGINEER (32), A.M. Inst. C.E., A.M.I. Struct. E., University diploma, experienced design Bridge and Structural Work Steel Reinforced Concrete, WISHES CHANGE, present "dead end" appointment for one of scope.—Address, P3805, The Engineer Office. P3805 B

ENERGETIC YOUNG ENGINEER, Hons. Degree Eng., knowledge German, Dutch, French, experience shops, D.O., erection, estimating and consulting work, SEEKS POSITION requiring initiative, home or abroad.—Write, BM/ABEX, W.C. 1. P3846 B

EXPERIENCED ENGINEER, Commercial and Practical, recently six years sales, India; excellent connections, steam, gas, oil engines, machine tools, general marketing, broad experience electrical pumping and marine installations, OPEN to RE-ENGAGEMENT. Now resident in India.—Address, P3869, The Engineer Office. P3869 B

EXPERIENCED STRUCTURAL DRAUGHTSMAN, at present senior in large office, SEEKS POSITION of RESPONSIBILITY. Thorough knowledge all departments, surveying, designing, erection, detailing, &c.—Address, P3871, The Engineer Office. P3871 B

SITUATIONS WANTED (continued)

LOCOMOTIVE SUPERINTENDENT, Home Railway (retired), DESIRES PART or WHOLE-TIME OCCUPATION. Would undertake supervision of placed contracts, rolling stock, or any kind of railway work, electrical or other machinery, steam or I.C. engines, boilers, &c. Correspondence invited.—Address, P3851, The Engineer Office. P3851 B

MOULDER, Leading Hand, SEEKS SITUATION (40), capable of taking charge, any class of engineering work, home or abroad, steel or iron.—Address, P3866, The Engineer Office. P3866 B

REFRIGERATING ENG. WANTS JOB, Erecting or Charge of Plant; able to undertake and advise on extension, &c.; experience with double suction multiple effect compressors; glutton for work.—Address, P3874, The Engineer Office. P3874 B

YOUNG MAN (23), with Connection Railway Companies and exporters in London, REQUIRES POSITION; energetic, adaptable, knowledge of French.—Address, P3860, The Engineer Office. P3860 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

If you wish to purchase or sell a Business connected with the Engineering or allied Industries consult:
HENRY BUTCHER, HALL & CO.,
63 & 64, CHANCERY LANE,
LONDON, W.C. 2.

GENTLEMAN WANTED, with About £10,000, to PURCHASE INTEREST of Retiring Partner in well-known Engineering Business.
For further particulars, address 6935, The Engineer Office. 6935 C

AGENCIES

AN Engineering Firm of Good Standing, with Office and Technical Staff in Cardiff, is PREPARED to take up REPRESENTATION of Engineering Firms wishing to do business in South Wales.—Address, 6934, The Engineer Office. 6934 D

ENGINEER WANTED by British Firm as AGENT, London and home counties, for SALE of SHUNTING LOCOMOTIVES. Must have good connections Municipal Officials, Public Works Contractors, Quarry Owners, &c. Preferably with other agencies, commission basis.—Address, 6991, The Engineer Office. 6991 D

GENTLEMAN, with First-class Connections Motor firms and engineers, REQUIRES further AGENCY.—Address, P3876, The Engineer Office. P3876 D

MISCELLANEOUS

AUTHORS DESIRING PROMPT PUBLICATION of their WORK should forward same Messrs. ARTHUR STOCKWELL, Ltd., 29, Ludgate-hill, London. Established 29 years. Advice free; 24-page booklet of Press commendations on application. 6620 I

GERMAN, TRANSLATIONS INTO, from ENGLISH, offered to qualified German Technical Man thoroughly used to translating machinery specifications and lists.—Address, P3867, The Engineer Office. P3867 I

PRESS NOTICES, Forewords, Pamphlets, &c., prepared in clear, attractive wording by Engineer with many years' editorial experience.—W. O. HORNAILL, A.M.I. Mech. E., A.M.I.E.E., 20, High Holborn, London. Phone, Chancery 7217. 6829 I

SAVE YOUR HIDES!
PREVENTS SLIPPING.
INCREASES EFFICIENCY.
REDUCES RUNNING COSTS.
LENGTHENS LIFE OF BELTING.
BY USING
Foliac
SOLID BELT DRESSING
(MADE IN ENGLAND.)
CLEAN TO HANDLE.
REQUIRES NO PREPARATION.
DOES NOT INJURE BELTING.
GRAPHITE PRODUCTS Ltd., 218-220, QUEEN'S ROAD, BATTERSEA, LONDON, S.W. 8.

. . THE . .
PREMIUM SYSTEM of PAYING WAGES
A few copies of this book, the standard work on the subject, are left. They form part of the fifth edition, which was revised to meet the great demand.
Copies in cloth boards, Two Shillings and Sixpence each net.
Post free to any address in the United Kingdom, 2s. 9d.
"THE ENGINEER" Office, 33, Norfolk Street, Strand, W.C.

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. Civil Engineers, Inst. Mech. E., London Univ., and ALL ENGINEERING EXAMINATIONS, personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Eng., London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., &c. Excellent results at all Exams., comprising hundreds of successes. Courses may commence at any time.—Apply to Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), A.M.I.C.E., &c., 9/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN-STREET, LIVERPOOL. Tel. No., Bank 1113.—London Office: 65, Chancery-lane, W.C. 2. Ex. B

PATENTS

KINGS PATENT AGENCY, Ltd. (B. T. KING, Reg. Patent Agent, G.B., U.S., and Can.). Advice handbook and cons. on Patents and Trade Marks FREE.—146a, Queen Victoria-street, London, E.C. 4. 40 years' refs. 'Phone: Central 0682. 6625 B

THE OWNERS of PATENTS Nos. 102,624, Relating to "Improvements in Multi-cylinder Motors with Radially Arranged Cylinders;" 128,653, for "Improvements relating to Internal Combustion Engine Valve Mechanism;" 140,529, for "Improvements in Connecting-rod Big Ends for Internal Combustion Engines;" and 145,398, for "Improvements in Springs for the Valves of Explosion Motors," are DESIROUS of NEGOTIATING with interested parties for the GRANTING of LICENCES thereunder on reasonable terms.—For information apply to Messrs. LLOYD WISE and CO., Chartered Patent Agents, 10, New-court, Lincoln's-inn, London, W.C. 2. 6923 B

THE PROPRIETOR of BRITISH PATENT No. 203,571, dated 31st October, 1922, relating to "Long-range Projectiles," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 6921 B

THE PROPRIETOR of BRITISH PATENT No. 148,863, dated November 5, 1914, pertaining to "Improvements in or relating to Well Tubing," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Illinois. 6969 B

THE PROPRIETOR of BRITISH PATENT No. 125,915, dated January 3, 1919, relating to "Improvements in or relating to the Formation of Metal Blanks of Varying Cross Section," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Ill. 6968 B

THE PROPRIETORS of PATENTS Nos. 152,669, 193,837, 260,252, for "Improvements in Addressing Machines," "Improvements in or relating to Addressing Machines," and "Addressing Machines," respectively, are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for purpose of EXPLOITING same and ensuring their full development and practical working in this country.—Address all communications in first instance to Haseltine, Lake and Co., Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C. 2. 6973 B

THE PROPRIETORS of BRITISH LETTERS PATENT No. 204,335, for "Improvements in Retorts for Use in Extracting Oil from Shale or the like," are DESIROUS of ENTERING into NEGOTIATIONS with interested parties either for the GRANTING of LICENCES thereunder on reasonable terms or for the SALE of the PATENT outright.—Communications please address to DICKER, POLLAK and MERCER, Chartered Patent Agents, 20-23, Holborn, London, E.C. 1. 6976 B

THE PROPRIETOR of BRITISH LETTERS PATENT No. 221,093, for "Improvements in Supports for Material to be Broken by Power or other Breaker Mechanism," is DESIROUS of ENTERING into NEGOTIATIONS with interested parties either for the GRANTING of LICENCES thereunder on reasonable terms or for the SALE of the PATENT outright.—Communications please address to DICKER, POLLAK and MERCER, Chartered Patent Agents, 20-23, Holborn, London, E.C. 1. 6977 B

THE PROPRIETOR of BRITISH PATENT No. 214,705, dated January 22, 1923, relating to "Improvements in the Regulation of Combustion," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 6991 B

THE PROPRIETOR of BRITISH PATENT No. 211,202, dated 13th November, 1922, relating to "Liquid Fuel Burners," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 7008 B

FOR SALE

ALL SECOND-HAND MODERN TOOLS, Guaranteed in working order and cheap to clear:—30in. Vertical Back-geared Drill with Tapping Motion, by Jones and Shipman; 7½in. Ward's Friction Geared Capstan with Chasing Saddle; 4in. Lang's Cutting-off Machine; Large Horizontal Keyseater, by Ludwig Loewe; No. 2A Becker Vertical Millers, &c.—Full list on application, DOWNING, 12, Longbridge-road, Balsall Heath, Birmingham. P3842 G

BEAM-BENDING and STRAIGHTENING MACHINES in progress, 14in. with dual heads, 10in., with triple heads, suitable motor or belt.—CHAMBERS, SCOTT and CO., Ltd., Machine Tool Makers, Motherwell. 6746 G

BOILERS, &c., DELIVERED FROM STOCK, subject to being unsold:—
New 30ft. by 7ft. 6in. LANCS., 180 lb. W.P.
New 11ft. by 5ft. CYL. TANKS or RECEIVERS, 80 lb. W.P.
New 10ft. by 4ft. 6in. AIR RECEIVER, 100 lb. W.P.
H. and T. DANKS (NETHERTON), Ltd., Netherton, Dudley. 6628 G

BRICK PLANT FOR DISPOSAL.—
Nearly New 16 H.P. Davey-Paxman Semi-portable Engine; Murray's No. 3 Wire Cut Machine with Crushing Rolls and Hoist complete; Belts, Pulleys and Shafting; Tangyes Pump with 3 Suction and 2 Delivery Pipes, Tanks; Range of New Timber Buildings; also Tip Trucks, Rails, Barrows, Caps, Side Lows, Hack Boards, Wheeling Plates.
Reason for selling, land required for building. Near London.
Apply, INGRAM, 22, Newgate-street, London. P3875 G

FOR SALE, LANCASHIRE BOILER, 29ft. by 7ft., complete with Furnaces and Fittings. In good condition, insured 180 lb.—Address, 7001, The Engineer Office. 7001 G

FOR SALE, NEW DRUMMOND S.S.S. and S. LATHE, 6in. centres, 6ft. bed, admits 3ft. 9in. between centres. Price £60 net, delivered free.—Address, 7006, The Engineer Office. 7006 G

For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

The Late Sir William Galloway.

THE death occurred at Cardiff on Wednesday of last week of Sir William Galloway, the well-known mining engineer. Sir William was a native of Paisley and was educated in Germany and at University College, London. At one time he was Inspector of Mines in the West of Scotland and in the South Wales district. Subsequently he held the Chair of Mining in the University of South Wales. His outstanding work was his contribution to the coal dust theory of explosions in mines. He spent several years investigating the subject and had the gratification of seeing his views generally adopted by mining authorities all over the world. In 1898 he made the first suggestion for the employment of stone dust as a means of reducing the danger of explosions in dusty mines. It is now recognised that stone dusting or stone dust barriers make coal dust safe from ignition and go a long way towards making it safe against the propagation of an explosion. Sir William's researches brought him recognition from many bodies, including the Royal Society, the Royal Society of Arts, the South Wales Institute of Engineers and the Monmouthshire and South Wales Coalowners' Association. He was given the honorary degree of Doctor of Science by the University of Wales and was knighted in 1924.

Armstrong's and Vickers'.

AT the annual meeting of Sir W. G. Armstrong, Whitworth and Co., Ltd., held in June, it was stated that among the possibilities of the future was the institution of closer working arrangements between the firm and Vickers Ltd. Conversations were at that date taking place, and it was said that in the plans under discussion the two firms might find material benefit. At the end of last week it was announced that the two firms had now signed a provisional agreement for the amalgamation of certain of their important works and businesses at present engaged principally in naval shipbuilding and in the manufacture of heavy and special steel and armaments. No further details have been disclosed, but it is stated that the execution of the agreement will involve the formation of a new company as from January 1st, 1928. The whole matter is to be submitted to the debenture holders and shareholders at an early date for their approval. The issued share capital of Armstrong Whitworth's amounts to £10,012,500 with £9,000,000 in debenture stocks and notes. That of Vickers Ltd. as reorganised amounts to £12,468,968 with a debenture issue of £3,284,783.

The Naval Building Programme.

THE fact that the Admiralty has invited tenders for eighteen naval vessels, to be ordered during the present financial year, appears to have created in some quarters an impression that the programme of naval construction has been augmented. That is not the case. The five-year programme approved by Parliament in 1925 specified the numbers and types of ships to be built each year from 1925–26 to 1929–30 inclusive, and no departure from this schedule is contemplated. This year's quota was fixed at three cruisers, nine destroyers and six submarines, and it is for these vessels that tenders are now being asked. With the exception of a cruiser and one or two submarines, all the craft in question will probably be built by contract. For the sake of the industries concerned, it is to be hoped that the orders will be placed as soon as possible. The five-year building plan provides in all for seventy-nine vessels and one floating dock. Up to now there have been ordered seven cruisers, six submarines, four gunboats, two mine-sweepers, one submarine depôt ship, one repair ship and the floating dock, a total of twenty-two units. The programme is, indeed, nearly twelve months behind time, on account of the delay in ordering ships due for construction in the second year. This year's quota of new tonnage has also been delayed, owing to the Government's decision to hold back the contracts until the result of the Geneva Conference was known. The only change which has taken place in the five-year programme involves not an increase, but a slight reduction, due to the substitution of two mine-sweepers for the four motor launches that were originally projected for last year. Of the three cruisers to be ordered this year, one is of the "A" class (10,000 tons), and the other two are "B" class ships (8400 tons). One of the nine destroyers will be designed as a flotilla leader.

An Electricity Scheme for Lincolnshire.

PRELIMINARY steps have been taken to apply for a provisional electricity supply order covering all parts of Lincolnshire, with the exception of those areas that already have a supply. A new company, with an initial capital of £200,000, is to be formed and eventually this capital will be increased to half a million. Arrangements have been made to enable all Local Authorities concerned to co-operate in the matter of finance. Towns, hamlets, villages and farms are to be provided with electricity, and it is expected that the scheme will give rise to a considerable demand for current in the rural parts. Already a general survey of Lincolnshire has been made, and a detailed survey will be undertaken in the near future. Dr. E. A. Ekstroem and Mr. R. Borlase Matthews are acting as consulting engineers for the scheme.

Marine Propelling Machinery.

SPEAKING at the luncheon which took place in connection with the recent trials of the Brazilian motor vessel Itapé—which ship is described elsewhere in the present issue—Mr. Alexander Galbraith, the general manager of William Beardmore and Co., Ltd., Dalmuir, gave some interesting particulars with regard to recent experimental work which has been carried out by the technical staff of that firm. Contrasting the performance of an ordinary reciprocating marine engine with that of the same engine when fitted with Beardmore-Caprotti valve gear, Mr. Galbraith stated that the latter arrangement would offer a fuel economy of 10 per cent., with a saving in weight of 15 per cent. and 20 per cent. saving in engine-room length. Such an engine has been recently completed at Messrs. Beardmore's Coatbridge works, and it will be installed in a cargo ship which will undergo final trials before the end of the present year. Continuing his remarks, Mr. Galbraith stated that if such an engine were to be fitted with an exhaust turbine of the Bauer-Wach type the fuel economy would be increased to 25 per cent. Taking as an example a 5000 S.H.P. triple-expansion steam engine using saturated steam, 58·3 tons of fuel per day would be required, which figure would be reduced to 46·3 tons for the Beardmore-Caprotti engine, 39·3 tons for the same engine with a Bauer-Wach exhaust turbine, and 22·5 tons for a supercharged marine oil engine or high-speed airless injection oil engine. Such engines as the two last named might be usefully employed, the speaker thought, either in connection with a hydraulic clutch or with electric transmission.

A Water Supply Scheme for Coventry.

A SCHEME which has been prepared by Sir Alexander Binnie, Son and Deacon for extending the water undertaking of the Coventry Corporation was considered at a meeting of the City Council held on Wednesday, November 9th. The scheme is a large one and a parliamentary Bill will be necessary before some of the work can be undertaken. The proposed extension embraces the sinking of new wells at Watery Lane, Brownshill Green, and Mount Nod, and also the construction of pumping stations on the two sites last named. In addition, work is to be undertaken on the distribution side in the high, middle, and low-level zones. In the low-level zone it is proposed to build a new service reservoir having a capacity of 9,000,000 gallons at Coundon and to install electrically driven pumping plant, both at the Spon End and Whitley stations. In the middle zone two new service reservoirs are contemplated, one at Meriden Ridge, with a capacity of 500,000 gallons, and one at Corley, having 10,000,000 gallons capacity, while a new water tower at Earlsdon is required with suitable connections to the mains. The scheme further provides for a new watch tower near Tile Hill in the high-level zone, along with certain works at the existing Corley reservoir, as well as new connections and mains. An estimated cost of £300,000 is mentioned as probably covering the work included in the proposed parliamentary Bill, while a further £50,000 will probably be needed to cover general extension mains.

Rural Telephones.

FOR the use of the public at small rural railway stations throughout the country the General Post Office is endeavouring to provide telephones. The scheme has been the subject of negotiations with the railway companies for some considerable time, but the difficulty has been to provide a remunerative service at places where the volume of traffic would not warrant the expense of erecting and maintaining a cabinet equipped with a telephone and a coin box. Under the scheme, which the Post Office has now under consideration, however, this difficulty will be removed. Instead of providing a cabinet it is proposed to install a telephone in any convenient place. In the majority of cases it will probably be placed in the railway station booking-office, and there will be no coin box. A railway official will have charge of the telephone and will receive the money paid for calls, and it is expected that this system of linking small country stations to the public telephone system will be of service to railway officials as well as to others in remote rural parts.

Proposed High-speed Atlantic Liners.

IN a Journal note published in our issue of October 28th we gave some preliminary particulars concerning the proposal to construct ten 20,000-ton Atlantic liners, which is being sponsored by the American Brown-Boveri Company and Mr. R. Wilder. Later news from New York gives new details of the scheme, which has now been laid before the United States Shipping Board, with a view to obtaining a loan so that construction may be begun. According to Mr. Wilder, the new ships, which will cost about three and a-half million pounds each, will, if sanctioned, be built at the Newport News, Fore River, and Camden shipbuilding yards. A length of 800ft. with a beam of 80ft. is mentioned, and Mr. Wilder comments on the somewhat narrow beam which will aid the high speed to be aimed at in order to cross the Atlantic in four days. From the fact that twelve boilers are mentioned—two being stand-by boilers—we understand that high-pressure steam turbine machinery is contemplated, although whether a direct geared drive or electric transmission is intended to be used has not been stated. The steam conditions are given as 400 lb. pressure with 700 deg. total superheat. The proposed vessels would, it is stated, make about thirty-seven round trips a year and would be laid up for about one month per year for reconditioning. It is stated that a crew of about 300 persons is to be carried on each ship and that the cargo facilities and handling appliances are to be such as will permit of a complete turn round within twelve hours of arrival at port.

A New Turbo-Generator Set at the St. Pancras Electricity Works.

A NEW 10,000-kW Ljungstrom turbo-generator set with an overload capacity of 25 per cent. has been installed by the Brush Electrical Engineering Company in the St. Pancras Borough Council's King's-road generating station. The turbine is designed for a stop valve pressure of 200 lb. per square inch, and a vacuum of 28½in., the steam being superheated to 688 deg. Fah. The turbine is coupled to two alternators with a combined capacity of 12,500 kV and wound for 5050/5300 volts. The condenser is of the Brush Company's two-flow type, designed to maintain a vacuum of 28½in. with the circulating water temperature not exceeding 70 deg. Fah. Air is extracted from the condenser by means of a Brush-Delas ejector, which is fitted with a surface feed heater in order to regain the heat from the steam used for operating the nozzles. The condensate is extracted by means of duplicate electrically driven "Pervac" extraction pumps supplied by Drysdale and Co., Ltd., of Glasgow, each pump being capable of dealing with the full amount of condensate when running at a speed of 1500 revolutions per minute and discharging against a total head of 55ft. The condensate is delivered through a 6in. Kent's patented "Venturi" meter of the indicating and recording type to the hot-well. The alternators are ventilated on the closed circuit system and the air is drawn through two air coolers, a separate cooler and fan being provided for each alternator. Air alarms and emergency inlet and outlet dampers are provided, the whole of this and the cooling equipment having been supplied by Heenan and Froude, Ltd., of Worcester. Each of the centrifugal fans is driven by a Brush motor at a speed of 1100 revolutions per minute, and each fan will deal with 25,000 cubic feet of air per minute. The fans were supplied by Standard and Pochin Bros., of Leicester. All the motors for driving the various auxiliaries were supplied by the Brush Electrical Engineering Company, whilst the switch and control gear for operating them was supplied by Brookhirst Switchgear, Ltd. Mr. W. Sydney Baynes, Chief Engineer to the St. Pancras Borough Council, has long been noted for keeping pace with the times, and in installing this new set he can claim the distinction of now having in his station the largest Ljungstrom turbine in England.

Synthetic Nitrogen.

ACCORDING to the annual report issued last week of the British Sulphate of Ammonia Federation, the annual production throughout the world of synthetic sulphate of ammonia is now almost equal in amount to the sulphate as obtained as a by-product in the operation of gasworks, &c., the respective figures being approximately 300,000 tons and 303,200 tons. The Federation estimates that if the synthetic nitrogen works now being constructed or planned are completed in accordance with announced intentions, the annual production of fixed nitrogen throughout the world will by 1930–31 amount to about 2,000,000 tons, to which may be added 200,000 tons representing the nitrate production of Chile. The combined figure exceeds the present annual consumption by about 900,000 tons, so that in order to absorb the increased output there will need to be an average increase in consumption during the next four years of 225,000 tons per annum. There would seem to be no evidence that such an increase is at all likely to take place. Judged from the records of the four years 1922–26, the average increase in consumption is about 65,000 tons a year. During these years the price of sulphate of ammonia has fallen, according to the Federation, from £13 6s. to £9 16s. per ton, representing a reduction of over 26 per cent. It would appear, therefore, that those who are about to embark on the manufacture of synthetic nitrogen must, in the words of the Federation's report, be prepared to face the level of price which is likely to be reached in an endeavour to quadruple the average annual increment of the past four years. The Federation, it need scarcely be remarked, is concerned with by-product ammonia and cannot therefore be expected to regard the increase in the output of synthetic nitrogen with equanimity.

An American Diary.

No. XVI.*

Boston and Cambridge.

We are drawing near to our journey's end. The long, narrow loop which we started westward from New York is beginning to close, and in a few days we shall be back at our starting point. Reaching Boston, we find ourselves in an area which has a different atmosphere from that through which we have travelled so far. It is the atmosphere of University life, and the tranquil detachment from contact with the busy industrial world which wisdom needs if it is to ponder fruitfully upon the essential affairs of the world. How can the midnight oil burn steadily in the gusts blown from the factory and the store; how can learning flourish if it has not stately buildings, green quads and that ineffable odour of wisdom that covers university towns? It is not for America—for a few hundred years to come—to know that marriage of the past and present which belongs to Oxford and Cambridge, a marriage which seems to declare continuously the perpetuity of knowledge, but, if it may not have that yet in its fulness, it may have the beginnings of it, and it may—perhaps wisely, perhaps unwisely, but certainly beautifully—have modern buildings modelled on the old, as are those of the charming Harkness Dormitories at Yale, and through them pay just tribute to the memory of the great past when learning was acquired and imparted for the higher elevation of the mind and soul of man, and with but little regard to the material facts of life. Few, indeed, are they who now can take learning for learning's sake. "What are your intentions, young man, with regard to my daughter?" demands the Mother of Knowledge. "Strictly dishonourable," replies the student; "I propose to prostitute her to the requirements of industry." So Oxford and Cambridge, Harvard and Yale, set up schools of engineering and chemistry, teach their students the subtlety of commerce, and fit them to become the tinkers and bagmen on the road of material progress.

Here at Harvard, which is in Cambridge, a section of Boston, we renewed acquaintance with Professor Marks, an Englishman, but more American than most Americans, who is head of the Engineering Schools and is well known by repute amongst us all for the steam tables which we call "Marks and Davis," and here, in the evening, we tucked our knees under a table at the Harvard Club with many professors, and chatted of the affairs of universities and the education of engineers.

Is it not written—

> "Solid men of Boston, make no long orations;
> Solid men of Boston, banish strong potations"?

The latter injunction we observed, for the wise are not as other men are, but look with suspicion upon that which calleth itself "Scotch," but of the former, why there is a season for all things, and the season for talking is when there are talkable people about you. And so we talked and listened, sometimes separately, when the evening was young, and both together and all together as it drew onwards to the curfew hour of the University, when, as in cathedral towns, communities break up, and under the lamp behind the drawn curtains Wisdom pores over its books—or studies bridge and polishes its golf clubs against the morrow. Let us tell now that at Yale the same hospitality met us, and we found that a delightful little dinner party had been arranged by Professor Wohlenberg—whose studies of combustion we have but recently dealt with in these columns—and at which the President of the University, Dr. Angel—a psychologist and an admirable talker—took the chair, and many professors, with Dr. Warren, Dean of Engineering, as their leader, helped us to a further insight into the principle and practice of engineering education in the United States.

Here it may be convenient to set down a few impressions which we received from these and many more discussions of the same matter. We have been asked if the standard of engineering education in the United States is as high as in this country. Our opinion, we give it with the greatest diffidence, is that, taken by-and-large, it is not; but—and the importance of this "but" cannot be too strongly insisted upon—the schools and colleges and universities are seeking to provide the class of man which industries require. The distinction is not so subtle as it appears to be at first sight. We may say of the best British technical education that it fits the complete student to become a teacher; of the American equivalent education that it fits the student to take a place in industry immediately upon leaving the university. As far as we were able to ascertain, the greatest trouble is taken in American colleges to consolidate the foundations; the relatively simple facts upon which clear thinking is imperative; but to the frills and variations upon the theme, less attention is paid. It is appreciated that ninety-nine out of every hundred students will devote their lives just to ordinary engineering which requires mainly a knowledge of a great many physical laws, but does not require the highest intimacy with those laws, and which needs a working acquaintance with no more than moderate arithmetic and mathematics. Given that the American universities are, in fact, turning out men suited for the vocation which they are destined to pursue, then it is a nice point whether their standard is higher or lower than ours. Fitness for need is the only test.

In their educational methods they appear to have the advantage of us in the greater number of teachers which they employ, a class more than ten or twelve in number being the exception; in their laboratories they lean towards small plant, so that two or three students may be able to carry out trials, and in relatively few cases are permanent "set-ups" of apparatus employed. The students are encouraged to devise their own tests and to set up the apparatus themselves. In some cases the floors of the laboratories are made purposely to facilitate that freedom of arrangement.

But the matter in which we were most interested was something more than the differences between the curriculum at one college and another, something that, in the long run, is more important than any method of teaching. We mean, of course, the making of men. It is relatively easy to turn out men with scientific and technical learning; it is far more difficult to develop personality and character, and without those two qualities no man gets very far, whereas a great number of men have done very useful, very great work, in the technical world with far less special knowledge than the average good student possesses. In universities that aspect of education is always considered, and we were interested to find both at Yale and Harvard, as we had found previously at Pennsylvania, a tendency to give more weight to humane studies in the training of engineers than of recent years has been deemed necessary. The difficulty is to find time, but if once it is fully agreed that humane studies are just as important as technical studies when the real world has to be faced, means of reaching the desired end will be found even if they entail the removal from the curriculum of certain subjects. Our impression is that, on the whole, there is a leaning amongst American educationists towards a broader education for engineers They are not all yet prepared to go as far as Professor Fernald, who makes the specialised course only two years, but many of them are thinking in that direction.

One thing that we found with regret was a diminishing respect for the value of apprenticeship or studentship in works. The graduates from Harvard and Yale go straight into definite remunerative posts in factories or laboratories. They do not, as most of our young engineers do, spend a few years learning the various branches of mechanical and civil engineering and, above all, meeting workmen on a common footing. There are, fortunately, many factories in America where great attention is paid to the training of "apprentices," but unfortunately the great universities seem to be of the opinion that the quality of the men they turn out is such that workshop training, with all that it means in the development of the engineering instinct, and with all that it effects by bringing future managers and employers into daily contact with workmen, is no longer necessary. In that, we venture to think, they are mistaken.

Whilst we are talking of education in Boston we must not forget that the engineering schools at Harvard have a very remarkable counterpart in the Massachusetts Institute of Technology—the M.I.T., as it is called throughout the country. It is an old school which began in a modest way, but through the gifts of old students and other philanthropists it possesses now extraordinarily fine buildings and laboratories, and whilst it still retains the character of a technical college, it has extended the scope of its studies, and its classes now differ but little from those of the University. Here, too, we were cordially entertained, for Professor Jackson brought together a number of the professors at a small but delightful luncheon party at which the subject of conversation was again, in the main, the training of engineers.

A Notable Research Laboratory.

In Cambridge there is a wonderful laboratory, possibly the most remarkable privately conducted research laboratory that the world can show. It was established by Mr. A. D. Little, and we were fortunate enough to be shown some of its work by him himself. What Mr. Little really relishes is some big industrial problem that awaits solution. He does not, we believe, "shoot into the blue." He does not conduct researches which have no definite object in view; there is a direct industrial intention in the work he undertakes. Problems are put before him by manufacturers, and he sets about the solution of them by attacking them on a scale which is perfectly astounding. Here you may find a complete paper factory, of small but workable size, set up to solve a problem in paper manufacture that had been brought to him; here again is a textile mill with all the essential machines, or here an elaborate chemical plant—not mere apparatus—for the solution of a technical problem. Let us give an example of the kind of problem with which this laboratory deals. A sugar cane grower had found that it was advantageous to cover the plants with strips of tarred paper, through which they forced their way. The paper retained the necessary moisture in the ground and the results were excellent; but the paper was expensive, and unless it could be produced cheaply the advantages of the method of growing would have to be surrendered. Mr. Little decided that the only solution was to make the paper locally from the sugar cane waste. He set up a plant to study the problem and solved it.

Amongst many exhibits of great interest there is one of which Mr. Little is particularly proud, with a twinkle in his eye. The old proverb runs: "You cannot make a silk purse out of a sow's ear." To prove that proverb false a silk purse of the kind familiar in the days of our grandfathers is displayed in a glass case. Yet in a measure the proverb is right, for the purse was made, not out of "a" sow's ear, but out of the ears of many sows which were sent from Chicago with a written guarantee of the sex of the original owners! The ears were rendered down to glue; the glue was dropped into an acetone solution, and from it, after many laborious efforts, it was drawn in silky threads which could be dyed and worked as readily as the product of the silkworm's entrails. Yet it is not a purse for everyone, for it cost one thousand pounds to make!

The Edgar Station.

At one time "Edgar" was called "Weymouth." Under that name it attracted no little attention amongst British engineers, by reason of the 1200 lb. plant which it contains. It is of particular interest to all who study power stations in this country, for it may be regarded as the exemplar on which the modifications which Mr. Thomas Roles has designed for Bradford have been modelled. In some respects it is just an ordinary 350 lb. station, turbo-generators for that pressure bearing the normal load with its fluctuation, whilst the 1200 lb. plant takes the base load at the highest efficiency. The station, by comparison with those which we have already seen, is not by any means a large one, for Boston is not a manufacturing centre, and the demand for current is relatively small. The initial plant, completed in 1925, consisted of three 350 lb. boilers and one high-pressure boiler. These supplied steam to two 32,000-kW turbines at normal pressure and one 3000-kW turbine at 1200 lb. All the steam was, and still is, supplied at about 700 deg. Fah. The 1200 lb. turbine exhausts at high pressure, 360 lb. and 500 deg. Fah., into a re-heater in the boiler, which restores the temperature to 700 deg. Fah., at which the steam enters the 350 lb. mains. The high-pressure boiler has been often described, but we may remind our readers that it has a drum, 4in. thick and 32ft. long, with an internal diameter of 4ft., fashioned from a seamless steel forging. As in other stations where reheating is employed, Columbia and Crawford-avenue, the boiler is divided, so to speak, into an upper and lower portion; the lower portion attends to the evaporation and superheating, whilst the upper portion, which is in fact a superheater of large size, owing to the reduced temperature of the gases, attends to the reheating. An interesting little detail was the fitting of small safety valves on the reheater. They were set to blow off just a little before the main valves at 1200 lb. would blow. There were stop valves in the small safety valve connections, so that the latter might be removed for grinding when necessary.

* No. XV. appeared November 4th.

As a matter of fact, no trouble has been experienced with the valves and frequent re-grinding, which was anticipated, has been found unnecessary. Of course, the main valves, if we recollect rightly there are four on the drum, only blow in an emergency, but the troubles of cut seats which were anticipated did not arise in practice, and the pilot safety valves have now been removed. The boiler is of the "press-button" type stoker-fired.

The little high-pressure turbine, which runs at a speed of 3600 r.p.m., develops, as we have said, about 3000 kW. The exhaust from it, after reheating, is sufficient for another 12,000 kW, so that the 1200 lb. boiler may be taken as giving 15,000 kW. When no high-pressure steam is used, the consumption per kW-hour for the station is, according to Mr. Moultrop, chief engineer, Edison Illuminating Company, of Boston, 1·02 lb.; if about one-third of the steam is used, first, in the high-pressure turbine, and then in the 350 lb. turbines, the consumption falls to 0·98 lb., equivalent to a coal saving of 4 per cent. If the whole station used the higher pressure, a coal economy of 12 per cent. might be expected.

One of the difficulties that was foreseen was the shaft packing of the high-pressure turbine shaft. The choice lay between carbon blocks and the labyrinth. The former was adopted, but owing to its failure in a short time it was replaced by the latter, which has worked without trouble ever since. Hand regulation of the boiler feed was used at first, but as it was troublesome, mainly on account of the small water capacity of the boiler, it was replaced by an automatic regulator which has proved quite satisfactory. The feed pumps are multi-stage centrifugals, electrically driven. The steam joints are of the Sargol type. It is of interest to note that all the cast steel fittings were examined by X-rays before acceptance.

We may add the very interesting fact that the actual cost of the plant per kilowatt worked out to nearly the same as that of the 350 lb. plant. That is due, in part, to the fact that the high-pressure plant gives a much higher output for its size. Mr. Moultrop estimated, when considering extensions of the station, that a saving of as much as 30 per cent. in cubic capacity could be effected by the use of the higher pressure throughout.

Those extensions are now being carried out, with one 10,000-kW turbine for 1200 lb. and two boilers for the same pressure. The high-pressure turbine, running at 3600 r.p.m., will exhaust, after reheating, into a normal 65,000-kW turbine running at 1800 r.p.m. Later a similar complete unit may be added.

(To be continued.)

River Rother Improvement Works.

THE river Rother rises at Rotherfield in Sussex, and flows eastward to a point near Iden, from whence it turns south across the marshes to the sea near Rye, and in its course and those of its tributaries it receives the run off and spring waters of a catchment area of 183,000 acres, some 43,000 of which are lowlands liable to flooding, and which depend entirely upon its outfall for their drainage. Prior to 55 B.C. what is now the marsh was a shallow bay, and it was gradually enclosed by embankments by the Romans up to 488 A.D.

The Rother at that time flowed to the sea past Appledore and by Old Romney, but its course changed from time to time, mainly in consequence of breaches caused by storms, until in 1763 it followed a course somewhat to the eastward of its present channel between Rye and the sea. Serious difficulties had arisen at that time owing to the mouth of the river becoming blocked with shingle, and in that year Smeaton was asked to advise on measures to remedy the trouble. He recommended a new cut, 80ft. wide at the top, 40ft. wide at the bottom and 10ft. deep. This work was executed, and in 1764 the old channel, having become entirely blocked, the new outfall and haven were opened opposite Winchelsea. In 1769, after great expenditure on harbour construction, the part of the river near Rye was diverted so as to fall into the harbour of Rye, that already received the waters of the Tillingham and Brede, which, however, were insufficient to keep the harbour open. These works proved ineffectual, owing to the accumulations of shingle from the west, and the absence of any protective works on that side, and this west harbour was finally abandoned about the year 1797.

In 1803 the Rev. Daniel Pape, curate of Rye, diverted the old silted—eastern—channel by means of a dam, and opened a new outfall channel more or less on the site of the present one. This work is described in a memorial addressed by Mr. Pape to the Society of Arts, which was dated April 3rd, 1803, and from which the plan—reproduced in Fig. 1—has been taken by permission of the Society.

R R on this plan indicates the new channel cut under the direction of Mr. Smeaton, and running into the sea opposite Winchelsea; M is the old course of the river; and N the new channel excavated by Mr. Pape, the dam having been placed at L. P P—described in Mr. Pape's memorial as "jutties"—were probably groynes, quite correctly placed to intercept the eastward littorial drift, and O was a stone pierhead. The old and the diverted channels of the river may be seen at the top of the engraving, the former somewhat eastward of Rye, and the other running into the harbour, which was formed by a channel on the south and west sides of the town, now known as the Rock Channel.

In 1812 Rennie was called in to recommend a remedy for the blocking of the channel by shingle. Reports were also made by Mr. Cubitt in 1839, who constructed the present Scots Float Sluice and Lock

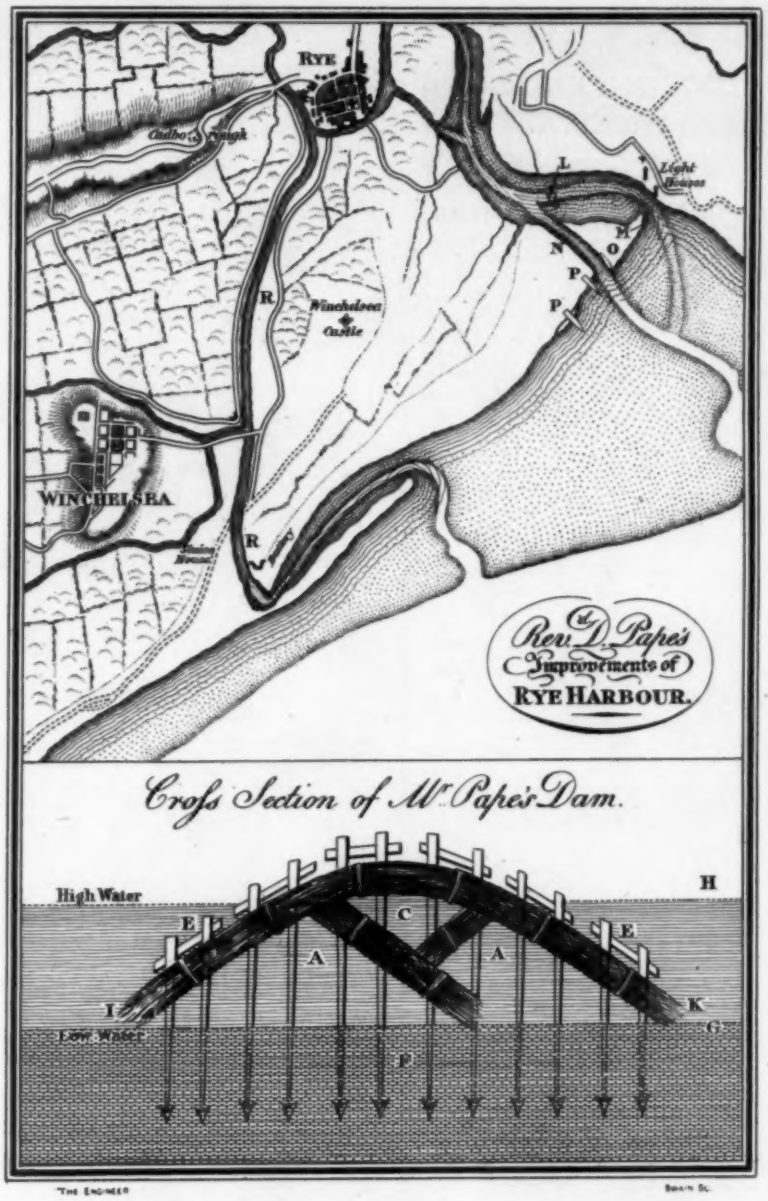


FIG. 1—FACSIMILE OF PLAN IN MR. PAPE'S MEMORIAL

at the inner end of the tidal compartment some distance above the town of Rye, and by Sir John Coode in 1879. Their recommendations, which generally included the construction of piers or groynes on the west side of the river mouth for the purpose of intercepting the eastward drift of the shingle, which is a well-known feature of the coast between Beachy Head and Dungeness, were only in part carried out, mainly on account of want of funds. The eastern stone pierhead originally constructed in 1803, was, however, extended to its present length of 3550ft., and completed in 1845.

The condition of the outfall, though varying from time to time according to the amount of scour resulting from wet or dry seasons, gradually deteriorated. In 1919 application was made by the Rye Harbour Commissioners to the Ministry of Transport for assistance in restoring the harbour. As a result of the report of the Ministry's Inspector, it became evident that the land drainage interests were paramount, and the matter was referred to the Ministry of Agriculture and Fisheries in 1920. In 1921, after a complete survey of the tidal compartment of the Rother had been made by the Ministry, experiments were carried out with explosives to determine how far the cost of remedial outfall works could be reduced by that means, since it was soon appreciated that the essential question was one of finance. A report upon these experiments, together with a suggested scheme to be operated by a joint over-riding authority, was prepared by Mr. C. H. J. Clayton, M. Inst. C.E., then Chief Drainage Engineer to the Ministry of Agriculture. This report, which was circulated to all concerned in May, 1921, recommended dealing with the whole drainage area of some 40,000 acres, and the entire sea frontage from Rye Mouth to Cliff End (Pett) as one unit, including groyning and faggoting the whole front, building a western training wall and seaward extension thereof, and the clearance by dredging and use of explosives of the outfall channel.

At a meeting of the local bodies and drainage authorities held at Ashford in November, 1921, the report was considered, but the authorities did not feel disposed to combine in a joint scheme, although a substantial measure of State assistance was offered, and the matter was dropped. Subsequently, as was predicted, the condition of the harbour entrance became rapidly worse. By December, 1923, huge accumulations of shingle had formed a spit across the harbour entrance, diverting the outfall channel for half a mile eastward and threatening to close it entirely. A view of this shingle spit is given in Fig. 2. Land in the Rother Valley was completely submerged, with no prospect of relief.

Application was made to the Ministry of Agriculture at this juncture for assistance from the funds at its disposal for the relief of unemployment, and a commencement was made with the erection of a western groyne to arrest further deposition of shingle and to induce a scouring effect upon the shingle spit to leeward. On the advice of Captain J. C. A. Roseveare, A.M. Inst. C.E., who had succeeded to the position of Chief Drainage Engineer to the Ministry of Agriculture on the retirement of Mr. Clayton, this scheme was, in 1924, further extended by the erection of reinforcing groynes on the west and the gradual extension and strengthening of the Eastern Pier by timber sheet piling across the eastward "run." The

outgoing waters were directed to bear upon the shingle spit on its inner side and help the scouring effect of the groyne on the seaward side. This, assisted by hand excavation in the shingle, culminated in a break through the spit in February, 1925, and released the waters impounded on the lower levels, and with the completion of the training works the channel was stabilised and remains in approximately the same line to this day.

The Rother Levels Commissioners, encouraged by the restoration of the outfall, then called upon Mr. C. H. J. Clayton, M. Inst. C.E., who had in 1923 retired from the Ministry's service, to advise upon the best means of dredging the tidal compartments, and as a result of his survey in 1925 he recommended

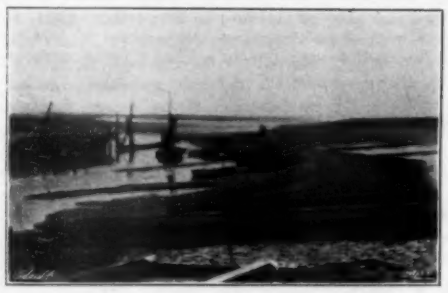


FIG. 2—SHINGLE SPIT AT HARBOUR ENTRANCE

a scheme of works which included some form of protection on the western side of the outfall. As a temporary measure the blasting of the bed of the tidal compartment with gelignite was put in hand in 1925. This novel expedient was attended with considerable measure of success, and a marked improvement resulted, but owing to the discontinuance of unemployment grants for drainage purposes it was impossible at that time to finance the proposed permanent scheme of works.

The condition of the lands drained by the Rother became again unsatisfactory, and last year, as a grant in aid of drainage works became available for assisting approved schemes, the Commissioners for the Kent and Sussex Rother Levels instructed Mr.

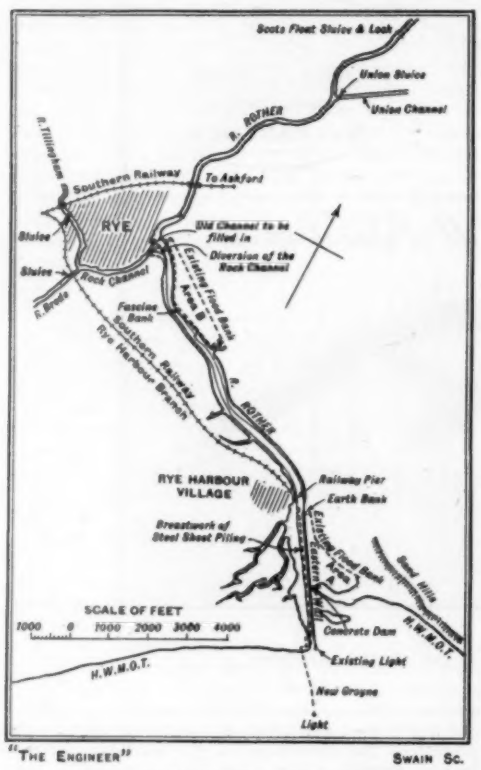


FIG. 3—PLAN SHOWING NEW WORKS

M. Du-Plat-Taylor, M. Inst. C.E., to report upon the question of clearing the river by dredging, and subsequently to report upon measures desirable to prevent accretions in the channel after the dredging had been completed. Mr. Du-Plat-Taylor's recommendations were approved by the Ministry of Agriculture and the Rother Commissioners, and subsequently by all the other bodies interested in the drainage through the Rother, namely, the Kent County Council; the East Sussex County Council; the Commissioners of Sewers for the Level of Walland Marsh and Eldertons Innings; the Commissioners of the East Guldeford Level; the Tillingham Drainage Board; the Commissioners of Sewers for the Levels within the Rapes of Pevensey and Hastings; and the Corporation of the Borough of Rye.

The work is now being carried out at the joint expense of the Ministry of Agriculture and Fisheries and the above-named bodies of Commissioners and the Corporation of Rye, under a scheme of contributions proportional to the area of land to be drained under the control of each body.

The works are illustrated in the plan—Fig. 3—and comprise the dredging of the channel from Scots Float Sluice to the sea, and also of the Rock Channel as far as the Brede and Tillingham sluices; the diversion of part of the Rock Channel; the construction of a substantial timber and concrete pier or groyne on the west side of the outfall; and various subsidiary works. A contract for the dredging work has been let to John Shelbourne and Co., Ltd., for execution by means of a bucket ladder dredger and reclamation pumping unit. The material dredged will be disposed of by pumping ashore upon two areas, marked respectively Area A and Area B in Fig. 3. Area A is bounded on the south side by banks of shingle, in which there is one opening immediately behind the outer end of the existing stone eastern wall, through which the tide flows in and out of the area; on the east side by existing flood banks and on the west side by the eastern wall.

The crown of the eastern wall is at such a level that at high water at spring tides the wall is submerged for its entire length. In order to retain the dredged material, therefore, this wall is being raised to 3in. above the level of the highest recorded spring tides by means of a concrete parapet wall and the gap or channel in the shingle bank behind it is being closed with a mass concrete wall. A low earth bank has been constructed at the north end of this area so as completely to enclose it. The dredged material will be pumped over the wall by the reclamation pump, sluices and gaps in the parapet being provided for the escape of the water.

Area B consists of "saltings" covered at high

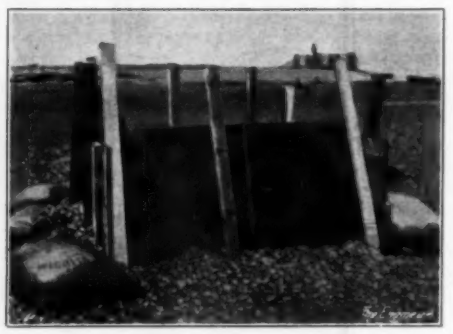


FIG. 4—A "CHEQUERBOARD" PANEL

water and bounded upon the east side by existing flood banks. For the purpose of retaining the dredged material on this reclamation area banks are to be pumped behind fascines erected on the saltings and composed of material known as "Chequerboard" fencing, which is being made and supplied by T. and C. Industries, Ltd., of Gloucester. This material consists of woven wood slabs on wood framing and made in panels 6ft. long. The panels will be fixed in position by means of chestnut stakes driven well down into the mud 3ft. apart and wired at their tops to inclined back stakes. The "Chequerboard" has sufficient interstices to provide for the escape of a good deal of the water without allowing the dredged material to pass, but trunks and sluices will also be provided at suitable points to deal with the water pumped on to the land with the dredgings. The "Chequerboard" panel is shown in the engraving Fig. 4. The area of reclamation site A is 28 acres 1075 yards, and that of site B 67 acres.

It will be seen from Fig. 3 that at the junction of the Rother and the Rock Channel—which brings into the Rother the waters of the Brede and the Tillingham—the Rock Channel points upstream. This seriously interferes with the evacuation of the ebb in both channels by causing eddies at the junction, and diminishes the ebb velocity. A new channel is to be excavated at the outer end of the Rock Channel with its outfall pointing downstream, and the existing outer end of the Rock Channel will be filled up with the excavated material arising from the formation of the new channel, supported by camp sheeting of steel piling.

On the west side of the outer part of the Rother Channel a breastwork of steel piling with timber wallings is being constructed for a length of 3300ft., 90ft. away from the face line of the eastern wall, for the purpose of confining the new low-water dredged channel and preventing shingle from rolling down from the banks on that side into the channel. To intercept the littoral drift from westwards a substantial groyne is to be constructed on the west side of the entrance, as shown in Fig. 3. This groyne is 2240ft. long, including a portion of an existing groyne incorporated with it, and for the greater part of its length is normal to the direction of the prevailing winds. The root of the groyne is sited 350ft. from the centre line of the new dredged channel in order to allow shingle which may be thrown over it in gales to come to rest at its natural slope without impinging upon the dredged channel. The groyne will be constructed of concrete contained by 3in. sheeting and supported by Oregon pine piles. The piles for a distance of 225ft. at the inner end project from 5ft. to 10ft. above the top of the concrete on the weather side, so as to allow of planking up at some future date to raise the height of the groyne if necessary. The height of the top of the groyne decreases gradually from the inner to the outer end, at which a dissolved acetylene flashing red light is to be provided on an open timber structure 30ft. high. A special piling plant, designed by the consulting engineer and constructed by the British Steel Piling Company, Ltd., the "Simplex" piles of which are being used in other parts of the works, will be employed in the construction of the groyne.

The aggregate for the concrete in the eastern parapet wall, dam and groyne is the local sea shingle and sand, and "Ferrocrete" rapid-hardening cement is being used throughout to enable advantage to be taken of fine weather and the piling plant, &c., to be run out quickly over the completed concrete work. Provision has been made in the scheme for planting the shingle banks inside the groyne with *Suaeda Fruticosa*, with a view to prevent movement of the shingle after the completion of the work.

All the work, other than dredging, is being carried out by direct administration, employing local labour, under the supervision of the consulting engineer. The resident engineer on the site is Mr. Stephen Leslie, A.M. Inst. C.E.

In Canada with the Empire Mining Congress.

(From a Delegate to the Congress.)

No. I.

THE Second (Triennial) Empire Mining and Metallurgical Congress, following upon the decision arrived at during the first Congress held at Wembley in 1924, opened its sessions at Montreal on August 22nd, when some hundreds of mining engineers and metallurgists from every important country in the Empire, together with many from foreign countries, gathered to hear Sir Robert Horne's opening speech as President.

In his opening remarks, Sir Robert reminded his hearers of the prominent part played by metals in the economic development of mankind, and suggested that it was particularly appropriate that the second meeting of the Congress should be held in Canada, as there was no country which had made such rapid progress within the past few years. Mineral production in the Dominion since 1886 had, he said, attained a total value of 4,150,000,000 dollars, and more than one-fourth of the total capital investment of the country was in mining and metallurgical plants. With a population only one-half of 1 per cent. of that of the world, Canada led as a producer of many of the most important minerals. Third in gold production, with one mine—the Hollinger, producing 5500 tons of ore daily—Canada produced 90 per cent. of the world's nickel, 80 per cent. of the asbestos, 55 per cent. of the cobalt, 9 per cent. of the silver, 8·7 per cent. of the lead, and 4 per cent. of the copper, and was even now only at the edge of discoveries which would exercise a dominant influence on the metal markets during the next ten years. Eighty per cent. of her area was entirely unprospected, and the provinces of Ontario and Quebec, especially, held particular promise of developments in the near future. In that development the newer methods of aerial and electrical prospecting might very likely play a part of some importance.

Before the war Great Britain was dangerously dependent upon foreign countries, either for minerals or for the smelting operations by which metals were made available for use. At the present time, except as regarded copper, the position was very much better, but the International Copper Cartel held the British consumer at a disadvantage. One million tons of copper were used annually before the war, whereas the present annual world consumption had risen to 1½ million tons and demand was increasing. South Africa and Canada would be called upon to supply the Empire's need, and the situation, particularly in Rhodesia, was hopeful. The tin and the nickel situation, in contrast, was quite different, as the world was almost entirely dependent upon the British Empire for its supplies, the province of Ontario in Canada producing the bulk of the nickel brought on to the market, and having known reserves sufficient to last for a hundred years at the present rate of consumption.

Reviewing the situation with regard to other metals, Sir Robert came at length to coal and suggested that in the newer methods of low-temperature carbonisation and hydrogenation Great Britain might find that economic factor which would change the course ot industrial history as completely as the application of coal to steam production had assisted in England's recovery after the Napoleonic wars.

Sir Thomas Holland's paper, which followed, provided the keynote of the later meetings of the Congress, and will no doubt lay the foundations of important developments throughout the Empire as time goes on. Entitled "A Proposed Review of the Mineral Resources of the Empire," the paper—which is endorsed by the Council of the Institution of Mining

and Metallurgy in London—contemplates the setting up in each of the Dominions, and in the larger Colonies, of committees of specialists entrusted with the duty of reviewing for each state concerned its mineral resources and smelting capabilities, having in mind the desirability of accumulating, in addition to the ordinary official statistics of production and movement, the essential data necessary to the formulation of a national and of an Empire economic policy, as well as for obtaining the information required in order to institute measures designed to secure military safety. The desirability of securing the regular analysis of the ordinary public statistics by those familiar with the trend of mining and metallurgical development was also emphasised, it being contended that there could thereby be brought together a collection of information which is not now accessible regarding minerals that might be worked, or areas that ought to be examined, but which under existing conditions are now neglected.

Last year, the total mineral production of the world amounted to nearly two thousand million tons, of which the British Empire produced about a quarter and the United States about two-fifths, production in the latter state being facilitated by freedom of movement between one part of its area and another, whilst movement within the Empire was impeded by tariff barriers and other obstacles to economic development. The argument conveyed in the paper itself was supported and illustrated by the presentation at the same meeting of four other papers prepared under the instructions of the Advisory Council on Minerals of the Imperial Institute, one being by Mr. Gilbert Stone, entitled "Observations upon Mining Law in the Empire;" another by Mr. G. V. Hobson on "Mica and its International Relationships; a third by Mr. Reginald Pawle on "The Empire's Tin Resources;" and the last by Sir Richard Redmayne on "The Organisation and Work of the Mineral Resources Department of the Imperial Institute."

Later discussions, as the delegates to the Congress moved through Canada brought forth further support to Sir Thomas Holland's plea for more systematic collection of knowledge, one contribution in particular being that of Sir Albert Kitson, Director of the Gold Coast Geological Survey, detailing the immense benefits to the Empire of the discovery during the war by that Survey of the vast deposits of manganese, which now constitute such an important source of supply of that metal.

During the two days spent by the Congress party in Montreal, the writer took an opportunity of calling on Mr. T. W. Harvie, General Manager and Chief Engineer of the Port of Montreal, who kindly deputed an assistant engineer to show him the working of the great cold storage warehouse and of Harbour Commissioners' Elevator No. 3. The cold storage warehouse, stated to be the finest and largest of its kind in the world, was built in 1922, when it was thought that Canada was likely to become a large exporter of chilled beef, but, such has been its utility to the shippers of other perishable foodstuffs both in Canada and in the United States, that a private company is now erecting another warehouse nearby in the port, as well as others at Toronto and elsewhere in the Dominion. The Commissioners' cold storage warehouse, adjacent to Place Viger Station (C.P.R.) and to the river front, is accessible easily from steamship, railway car and motor lorry. It is 536ft. long by 103ft. wide and has eight floors and a basement, as well as numerous cellars beneath, with a total capacity of 4,628,000 cubic feet. Six of the floors are insulated and refrigerated to temperatures ranging from 34 deg. Fah. to — 5 deg. Fah. Fire protection is provided by four towers on the roof, in which is stored water to be sprayed throughout the building at need by an automatic sprinkler system, the system being connected with the city mains as an additional safeguard. Minute changes in temperature are recorded automatically in each chamber, any change beyond the safety point—such as would arise from an outbreak of fire, local or general—at once setting the sprinklers in operation. Automatic fire-closing doors are provided between two approximately equal divisions of the building.

Refrigeration is produced by the medium of calcium chloride in solution, cooled in a power-house nearby by the expansion of anhydrous ammonia, and distributed to the chambers by a 2in. pipe system having a total length of 277,000ft. Rooms containing foodstuffs likely to contaminate goods subsequently introduced are ozonised, and air is kept in constant circulation. Cooling water for the ammonia condenser is obtained both from the river and from an artesian well 1150ft. deep, an hourly supply of 8000 gallons being available at a constant temperature of 50 deg. Fah. Ice is manufactured in the building for use in the railway refrigerator vans. The ammonia compressors in the power-house number three, with a total capacity when in use of 150 tons per day.

Each floor is reached by elevators, five in number, four of which reach the basement, and meat and heavy freight can be run from sidings to elevators suspended from overhead tracks.

Grain elevator No. 3, the only one which the writer found time to visit, is a structure with a storage capacity of two million bushels; the four now in existence in the port having a capacity exceeding twelve million bushels, serving at need thirty vessels at their berths, and of these twenty-three simultaneously at the rate of 450,000 bushels an hour. This particular elevator can handle twenty-eight huge box cars every hour from the adjacent railway tracks, these being unloaded into the hoppers under the line by the Metcalfe car dumper, which hoists and tilts the loaded cars in one mechanical operation. At other elevators in the port the hoisted cars are shaken in order to keep the grain in movement. This elevator, which is shortly to be enlarged to 5,000,000 bushels capacity, and to more than that later, has at present three segregated units, including two storage units of 1,000,000 bushels capacity and the central working house for elevating the grain and running the belt conveyors, every possible precaution being taken against dust explosions. Grain is carried underground from the hoppers below the car dumping shed, and thence by receiving legs which mount to the great concrete bins in the open air to a distance of about 100ft. Dangerous gases have therefore an opportunity to escape before the grain is weighed into the bins, and the various chambers through which the grain proceeds on its subsequent journey to the shipping legs are provided with heavy concrete division walls. The elevator at the present time has a wagon unloading shed on the railway tracks; a receiving house, two million-bushel bins, two shipping houses, four travelling marine towers, and conveyor galleries leading to five ocean steamer berths.

Whilst arriving in the port on the R.M.S. Alaunia, and later after shooting the Lachine Rapids on the brave ship Empress, delegates were afforded a fleeting view of the new Montreal South Shore Bridge now under construction by the Harbour Commissioners across the various channels and islands from the city of Montreal to the town of Longueil, on the south shore of the St. Lawrence, a total length of about two miles. The bridge is intended for vehicular and pedestrian traffic; the roadway is to be 37½ft. in width, allowing for automobile traffic down the centre and tramway traffic down each side. The main span is to have a vertical clearance of 162ft. above high water in the river measured from the 500ft. middle section. The fairway for vessels is to be 1000ft.

Many new developments are expected in the port during the immediate future, loans for upwards of ten million dollars having been recently sanctioned by the Dominion Government for expenditure by the Harbour Commission.

The Congress trains left Montreal for Ottawa on Tuesday, August 23rd, at midnight, immediately following a great banquet in the Hotel Windsor. The following morning found us in the capital city of Canada on a day of brilliant sunshine and cool, bracing air. The party was welcomed at luncheon by the Governor-General, the Minister of Mines, and other public men, and an enjoyable conversazione took place in the evening among the fossils and other exhibits at the Geological Survey Museum. Visits were made to the Royal Mint, the ore-dressing and other laboratories of the Mines Branch of the Department of Mines, as well as to the splendid new Parliament buildings, in which there is one of the largest and finest carillons of bells in the world. One party, however, was motored out to the new hydro-electric power plants and paper mills in the Gatineau River Valley, on the Quebec side of the Ottawa River, where we were enabled to inspect the Chelsea and Farmers' Rapids plants of the Gatineau Power Company, a subsidiary of the great Canadian International Paper Company.

The Gatineau Power Company, which controls water power sites with an aggregate potential capacity of more than 700,000 horse-power on the Ottawa River, and on its tributaries the Gatineau, Rouge, Lièvre, North Nelson, Blanche, Quinze and Gordon, expects, when its plans are completed, to rank as one of the largest hydro-electric power supply corporations on the North American continent. The initial installations now in operation or under construction include a total of 475,000 H.P., comprising four 34,000 H.P. units at the Chelsea plant, four at Farmers' of the same size, four at Temiskaming (two of 7600 H.P. and two of 3700 H.P.), and six at Paugan, of 34,000 H.P. each, as well as certain other developments totalling 16,000 H.P. on the Rouge River, North River and Ouareau River. This original installation will generate from the end of the year 1928 approximately 2,150,000,000 kilowatt-hours, which is about 2¾ per cent. of the total kilowatt-hours generated by public utility plants throughout the area of the United States, or approximately 41½ per cent. of the kilowatt-hours generated in New England, and 70 per cent. of the output of the Ontario Hydro-Electric Power Commission in its twenty-one plants. The company owns or controls the high-tension transmission lines and distribution lines serving most of the country between Hull and Montreal and extending north and east to St. Jérome, St. Lin, and Rawdon.

Contracts have been entered into with the Hydro-Electric Power Commission of Ontario for the supply of power to Toronto; as well as with the Canadian International Paper Company, the Canada Cement Company, Ltd., and the Hull Electric Company.

The Chelsea plant, which we visited, is designed for an ultimate installation of five units of 34,000 H.P. each, and will operate under a head of 96ft. The dam is 1600ft. long and 100ft. in height. The height of the power-house is about 160ft. The dam will back the river up a distance of 26 miles to the tail-race at Paugan Falls, impounding about 440,000,000 cubic feet of water. The Farmers' hydro-electric development is 7000ft. downstream from Chelsea, and will back up the water to the tail-race at Chelsea. The power-house is designed for five units of 24,000 H.P. each, and will operate under a head of 66ft. The total length of the dam at Farmers', including spillway, power-house and wing dams, is 4800ft., and its maximum height is 75ft. This plant will operate in parallel with Chelsea, power being generated at 6600 volts and stepped up to 110,000 volts for transmission.

We were unable to get as far up the river as the Paugan plant, which is 26 miles above Chelsea and 32 miles from the confluence of the Gatineau with the Ottawa River. The dam which is being built below the falls will, I understand, back the river up a distance of 30 miles, submerging nine falls and rapids and creating a head of 136ft. The Paugan plant is designed for eight units of 34,000 H.P. each, and power will be generated at 6600 volts and stepped up to 220,000 volts for transmission.

By combining the operation of the Chelsea, Farmers' and Paugan developments into one system, the company expects to utilise to the best advantage the total fall of the river for a distance of 62 miles from the Ottawa River upwards and to develop at least two-thirds of the available power in the whole stream. The storage provided by the lakes created by the Chelsea and Paugan dams will assist materially in the regulation of the system, and should eliminate all likelihood of ice trouble.

Lumbering operations have been conducted along the Gatineau and its tributaries for many years, and timber dams have been constructed on a number of the latter in order to facilitate log floating. These works have hitherto constituted the only attempt at stream regulation and have been used only for log driving. The Gatineau Power Company, however, under the direction of the Quebec Streams Commission, is now building a large concrete dam on the Gatineau River, about 30 miles above Maniwaki. The reservoir formed by this—the Mercier storage dam—will have an estimated storage capacity of 95,000,000,000 cubic feet, and the ultimate regulated flow of the river will be between 10,000 and 11,000 cubic feet per second. This new reservoir above the Mercier dam will be the third largest artificial storage reservoir in the world, following after the Gatun Dam in the Panama Canal zone and that above the Gouin Dam on the St. Maurice River regulating the flow of water to the plants which I visited at Shawinigan Falls and Grand' Mère just before my return home from the Congress.

I was unable to secure statistical data regarding the immense plant of the Canadian International Paper Company at West Templeton on the Ottawa River, but anyone passing through the vast halls in which the grinding, digesting and paper manufacture is carried out will believe readily that the plant is one of the largest in the world, rivalling in size even the great Palaces of Engineering and of Industry at Wembley. Paper 20ft. wide comes off the machines before cutting to commercial sizes for market.

The Congress trains reached Toronto on August 25th, the delegates being boarded at the University, which has its various Faculties in ideal surroundings in a park in the centre of the city quite close to the Provincial Parliament Buildings. Technical sessions were held at the Mining Building, and a great banquet was given at Hart House, at which the Premier of the Province and others made eloquent speeches of welcome, the main texture of which was repeated by other Premiers and lesser folk throughout our tour to the Pacific Coast, our appreciation of the wonderful hospitality of the Canadian people rising in a crescendo as the trains made their way ever westward. In Toronto we had opportunity of observing the courageous manner in which the city is building a harbour and an industrial district by dredging up sand from Lake Ontario, spending upwards of 30,000,000 dollars in the works and in the creation of an industrial district of 1000 acres or more. The harbour is constructed, of course, primarily with an eye to the great lake traffic from the head of Lake Superior through the Welland Canal and the new Welland Ship Canal now under construction, but the authorities are not blind to developments in traffic which may follow the completion of the Great Lakes–St. Lawrence waterway to the ocean, as and when the Canadian and the United States Governments may decide to permit construction work to proceed.

From Toronto we took train to the great plant of the Steel Company of Canada at Hamilton, where are assembled iron ores from Lake Superior mines in the United States, American coal and local limestone. The plant has two blast-furnaces, capable of producing annually 290,000 tons of basic, foundry and malleable pig iron. The coking plant consists of eighty Wilputte by-product ovens, with an annual capacity of 365,000 tons of coke. The ovens are provided with a benzol recovery plant, capable of producing annually 2,190,000 gallons of light oil, and with a plant for recovering by-product ammonia in the 'form of sulphate.

The steel plant is equipped with eleven basic open-hearth furnaces and one 100-ton mixer, the fuels used being coke-oven gas, tar, and producer gas made in six Morgan producers. The capacity of the Hamilton plant is 300,000 tons of ingots per annum.

The rolling mill is provided with modern machinery and has a capacity of 260,000 tons of blooms, billets

SWITCHGEAR AT THE FERRYBRIDGE ELECTRIC POWER STATION

THE BRITISH THOMSON-HOUSTON COMPANY, LTD., LONDON AND RUGBY, ENGINEERS

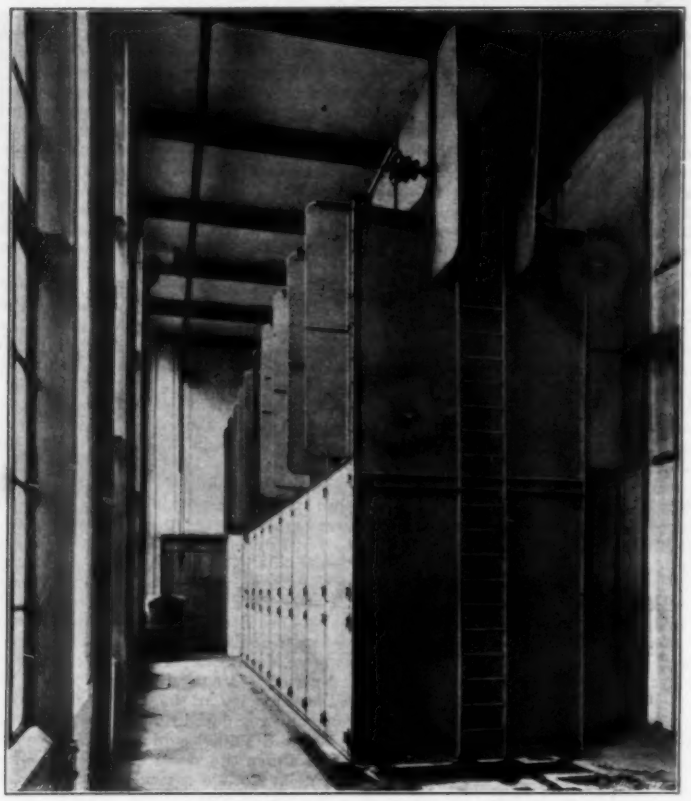


FIG. 13—ARRANGEMENT OF H.T. EQUIPMENT

FIG. 14—INSPECTION GALLERY ABOVE H.T. EQUIPMENT

and sheet bars per annum. There are three sheet mills with accessory furnaces for heating the sheet bars, two cold mills, a six-box annealing furnace, and a spike shop for producing railway sleeper—tie—spikes. The capacity of this part of the plant is 150,000 tons of hot-rolled products, including wire rods, merchant bars, light structural shapes, agricultural implement shapes, and similar stock. Rolled products only are produced by the "Ontario Works" at Hamilton, which has an annual capacity of 70,000 tons. Wire and wire products are turned out by the "Canada Works" at Hamilton, which has a capacity of 32,000 tons per annum. Miscellaneous hardware and small parts are produced by the company's plants at Brantford, London, Toronto, Belleville, Gananoque and Montreal.

Steel furnaces are also operated in Hamilton by Dominion Foundries and Steel, Ltd., with equipment including four acid open-hearth furnaces, 15 to 25 tons each, two 35-ton basic open hearths, and two 6-ton Héroult electric furnaces. There is a new Semet-Soivay coke oven plant in the city, established mainly to provide domestic coke as an alternative to the anthracite coal used in Canadian homes, the supply of which from Pennsylvania is becoming expensive and uncertain year by year as depletion in that field proceeds.

(To be continued.)

The Ferrybridge Station of the Yorkshire Electric Power Company.

No. III. (*Conclusion*).*

To complete our description of the Ferrybridge generating station we propose to give some particulars of the transformers, switchgear and other electrical equipment.

It will be remembered that the turbo-alternators generate 50-period three-phase current at 11,000 volts. The energy at that voltage is delivered to two groups of three single-phase 10,500/19,050-volt transformers, which are arranged outside the western frontage of the turbine house. These transformers, of which a view of one group is given in Fig. 17, page 540, were supplied by Ferranti, Ltd., of Hollinwood. Each has a capacity of 8333⅓ kVA, and each group of three has therefore a capacity of 25,000 kVA. The groups are delta-star connected with the neutral point earthed. The transformers, which are of the double-wound core pattern, rated in accordance with the B.E.S.A. specification, are of the forced-cooled oil-immersed type, the cooling oil being circulated by external motor-driven pumps through the transformer and through separate water-cooled oil coolers. In construction they follow closely the makers' standard practice and need not therefore be described at any great length in the present instance, but it may be said that all joints in the cores are interleaved, and that the yoke clamping framework is held by four large insulated square bolts keyed into each corner, the laminations being cut to receive them. With this arrangement no tie bolts between the top and bottom yokes are required. The makers point out that the advantages of this method of construction are very real, since it is extremely difficult to insulate vertical tie bolts from the high-tension windings. The joints between the core leg and yoke are stepped to facilitate the dismantling and assembly of the latter. The windings are of the circular concentric type, both low and high-tension sections being a single-layer helical coil consisting of several strands of copper ribbon in parallel, and wound on solid bakelite tubes. Oil ducts are formed both in and over each winding. The main insulation between the high and low-tension windings and between the windings and the frame consists of a combination of oil and solid barriers.

The double-wound core type with concentric coils has been adopted on account of the great resistance offered to the mechanical effects of short-circuit stresses. The makers' spring coil support has been fitted at the centre of the high-tension winding, where it causes a minimum of disturbance to the magnetic balance. The axial components of unbalanced short-circuit stresses act in the same direction on the coils, as does the pressure of the springs, so that there is no tendency for the latter to compress under short-circuit conditions.

The cooling equipment, which, as will be observed from Fig. 18, page 540, is arranged inside the turbine house, is provided in duplicate for each group of transformers. Each circulating pump in each set is driven by a separate motor, one being an alternating current and the other a direct-current machine.

The main switchgear, which, as has already been explained, is housed in a building separated some little way from the power-house itself, has a rupturing capacity of 1,500,000 kVA. It was supplied by the British Thomson-Houston Company, Ltd., and was made at its Willesden works. The generators are coupled direct to the transformers and all the switching is done on the 33,000-volt side by means of isolated-phase switchgear.

It may here be said that station power is obtained from 11,000-volt bus-bars which are supplied through step-down transformers from the 33,000 bars, and that the station auxiliaries are supplied with 400-volt current from step-down transformers from the 11,000-volt bars. For transforming 33,000-volt to 11,000-volt current a group of three transformers was supplied by the Brush Electrical Engineering Company, Ltd., of Loughborough. The group is arranged outside the building in line with the two groups of 11,000/33,000-volt transformers.

To return to the switch house. The three phases of the switchgear are each accommodated in separate cubicles on the same floor, the oil circuit breakers being electrically operated from the control room, which is situated at one end of the switch house, to which it runs at right angles. One solenoid operating device is provided for the three single-pole circuit breaker units, which are mechanically coupled through mechanisms running under the floor. All isolators, selectors and earthing switches are operated in threes by signal levers, and their mechanisms are so arranged that the rods which couple the various cranks are in tension whether the switches are being opened or closed. The solenoid pillars and signal lever handles—which are shown in Fig. 19—are accommodated in a special passageway running parallel with the main gear and separated therefrom by a wall.

The switchgear itself is of the "open" type—that is, it is not enclosed in cubicles—and all the insulators are of the outdoor pattern, so as to increase the factor of safety and to reduce the frequency of cleaning operations. The apparatus is mounted on a framework of rolled steel sections, and sheet steel screens are provided between the equipments, so as to allow of safe access to a "dead" circuit while adjacent circuits are "alive." Movable flexible shutters are also fitted to interpose between the clip contacts and blades of the bus-bar selectors when the latter are open, so as to screen an isolated equipment from the bus-bars. From Fig. 13, which is a general arrangement of an equipment, it will be observed that two sets of bus-bars—main and auxiliary—are mounted on the top of the structure with a screened inspection gallery between them. A view looking down on this gallery is given in Fig. 14, in which the type of insulator employed will be observed.

The oil circuit breaker top plate is at a height of approximately 9ft. from the ground, and at that level the top portion of the cubicle is separated from the bottom by means of a horizontal sheet steel barrier, the top part of the cubicle being open, while the bottom part is enclosed by sheet steel doors, which are furnished with locks. The inspection gallery at the top is screened from the bus-bars by flexible shutters, which can be let down between the contacts of the bus-bar selector switches, and also by sliding screens which can only be moved after the corresponding bus-bar has been completely isolated.

With this arrangement, where potential transformers are required, they are arranged with their tank tops level with this horizontal screen, connection being made to the main circuit through a spring contact on the transformer bushing and an extension to the hinge contact of the cable insulator. The transformer can be lowered to the ground when it is necessary to disconnect it from the main circuit, and the members which serve as guides for the transformers are fitted with projections which provide means for the operator to climb to the top portion of the cubicle through a manhole which can only be uncovered after the transformer has been lowered

* No. II. appeared November 4th.

to the ground, thus disconnecting both primary and secondary windings. No movable ladders are permitted inside the switch house.

One of the oil circuit breakers is shown in Fig. 15. These breakers are of the circular tank pattern, each single-pole unit being built up on a heavy cast top plate, which carries the bushings and mechanism. The bushings are composed of an upper and a lower porcelain member, cemented to a central cast iron ring, which encloses the bushing transformers where required. The space between the conductor and the porcelain shell is filled with insulating compound, the conductor being insulated with special cloth for the full voltage of the system. The central cast iron ring is extended down the lower porcelain member, under the surface of the oil, so as to eliminate possibilities of corona along the insulator surface or of the ignition of inflammable gases in the air space above the oil.

The breaker contacts are of the explosion pot type and are reinforced, where necessary, by finger pattern contacts, which engage on wedge-shaped portions of the breaker cross bars. The explosion pot consists of brass segments held together by garter springs. The contact rods fixed to the cross bar are provided with rounded renewable arcing tips, and the arc being drawn to the rounded end where the breaker opens, does not affect the parallel sides of the rod which engage with the fixed contacts. With this form of circuit breaker, when additional contacts are necessary for the current capacity of the circuit, multiple fingers are attached to extensions of the bracket

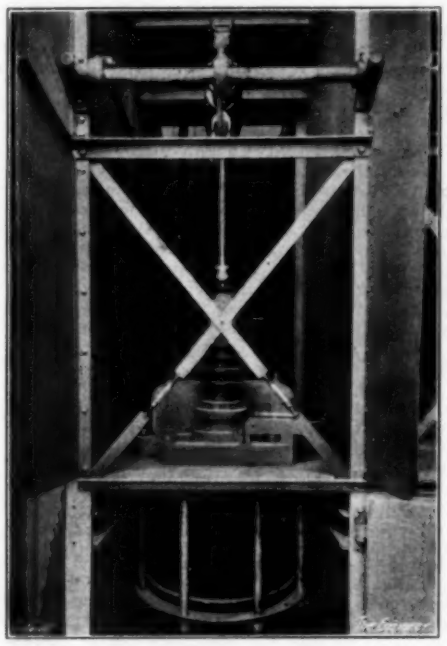


FIG. 15—H.T. OIL CIRCUIT BREAKER—B.T.H.

which carries the explosion pot. Each finger is provided with a strong backing spring to ensure good contact.

The breaker mechanism is enclosed in the top cover and is specially designed to withstand the heavy stresses brought to bear on the cross bar when the breaker carries short-circuit currents. The fixed contacts are also braced to prevent their spreading under the same conditions, and the straps of insulating material forming the ties also serve to carry a guide for the specially treated wooden tension rods. Since the mechanism is enclosed by the top cover of the breaker it operates in an oily atmosphere, and it is also, the makers claim, balanced against the racking effect which is experienced in some other designs when under high pressure in the tank. Powerful throw-off springs are fitted to give a high speed of break, which is accentuated under heavy fault conditions by the action of the explosion pots. There are oil dashpots to absorb the energy of the moving parts at the end of the stroke, and to prevent rebounding of the moving contacts.

The tanks are built up of ¾in. welded steel and are reinforced, at the level of the explosion pot contacts, by angle iron welded to the sides and extending completely round the circumference. This angle is used to attach the tank to the top cover by means of eight bolts. The tank has an insulated lining and the joint between the top cover and the tank is packed to render it air and oil-tight. A plugged filling elbow and drain cock with an oil level gauge and a thermometer pocket are provided for each tank. Pebble-filled separating chambers and vent pipes are fitted to the switches, the three pipes from the single-pole units of each equipment being connected to one header, which runs under the floor and forms a drain for the gravel-filled troughs. A separate tank lifting device is provided in connection with the oil circuit breakers, and it is capable of raising and lowering a complete single-pole breaker unit with the tank full of oil if required.

All the selectors, isolators, and earthing switches are remote hand controlled. Each equipment has four operating levers, three of which—those operating the bus-bar selectors and the cable isolator—are mounted by the side of the solenoid mechanism, while the fourth—that operating the special earthing switch—is mounted on a separate base. The base of these operating levers contains mechanical interlocking devices and electrical interlocking switches. The hinge contacts of the bus-bar selectors are mounted on the caps of insulators, two insulators rigidly coupled together being used in the case of the heavier currents to give greater rigidity, while the cable isolator hinge contact is mounted on the cable sealing box insulator. Clip contacts in the case of the bus-bar selectors are mounted on the bus-bars, which in turn are supported by insulators attached to the framework between the equipments. The cable isolator clip contact is carried by the oil circuit breaker bushing. This arrangement entails the use of a minimum number of insulators and hence reduces the number of points at which breakdown could occur, as well as lessening the time occupied in cleaning operations.

The blades of the switches are made girder shaped to give rigidity, and special cast flares are fitted to the clip contacts to guide the blades into contact when the switch is being closed. The movement of the blades is effected by means of cranks and insulated operating rods, the insulation on the rods consisting of a special moulded rubber compound. The switch mechanisms are balanced in order to reduce the effort required to operate them.

The current transformers for the operation of the instruments, meters, and overload relays are accommodated in the oil circuit breaker bushings, and for the lower ratios, with which phase accuracy cannot be obtained with standard bar primary transformers, the B.T.H. Company's patented auxiliary teazer winding scheme is adopted. Under this scheme the secondary winding of a transformer on one phase is connected in series with a few turns of a transformer on another phase, which results in the production of a current of the correct phase angle. All the potential transformers are oil immersed. They are single-phase, 33,000/110-volt instruments, but since both primary and secondary windings are star-connected the voltage impressed on the primary winding is only 19,000, although they are insulated for 33,000 volts to earth continuously. The transformers are arranged to slide up and down a guide and are raised and lowered by means of a movable winch type mechanism and carriage. In the normal position contact is made with both primary and secondary windings by means of spring contacts, and after a transformer is raised to its position in contact with the main circuits it is held by two cleats fixed to the guide. The cleats can also be attached to the guide lower down so as to allow of an isolated position for the transformer. For each of the transformers there is a two-way switch, which either earths one end of the primary winding or connects it to the other terminal for the purpose of pressure testing.

The control panels are of the hydraulically flattened sheet steel type, those for the generator and voltage regulator equipments being of the bench pattern, while the rest are vertical. There are indicating panels above the control panels, and on each is a single line diagram of the system to which it refers, the operation of the oil circuit breakers, isolating switches, &c., being automatically indicated by means of relays, in addition to the usual signal lamps on the control panels. One of the bench pattern boards is illustrated in Fig. 20, page 540, and the indicating panels will be observed above the control panels.

For providing current for station purposes there are two motor generator sets and a storage battery, the former supplied by Mather and Platt, Ltd., of Manchester, and the latter by the Chloride Electrical Storage Company, Ltd., of Clifton Junction, near Manchester. Each motor generator set comprises a 500-kW, shunt-wound, 500-volt, direct-current generator, provided with pole-face compensating windings, direct coupled to a 720 B.H.P. three-phase, 50-cycle, 400-volt induction motor, with a wound rotor. Both machines in each set are of the open type, and have two outside pedestal bearings with a single pedestal bearing between the two machines. These sets operate at a speed of 1000/990 r.p.m.

The Chloride battery consists of 240 cells, of the TGAW ten-cells pattern, designed to give an output of 1680 ampère-hours in ten hours, and approximately 650 kW over a period of 15 minutes. The cells are of the lead-lined wood-box type, and are supported on large porcelain insulating units. The method of controlling this battery is interesting. Normally, the battery of 240 cells floats on the 500-Volt direct-current auxiliary plant bus-bars in parallel with the motor generator. A motor-driven booster—to which we shall refer immediately—is held in readiness, its duty being to boost up the falling voltage of the battery when it is called upon to discharge. Immediately the motor generators cease to operate normally, the auxiliary load is taken over by the battery, which has been floating on the bus-bars.

The automatic reversible battery booster set was supplied by Mather and Platt, Ltd., through the Chloride Battery Company. It comprises a 0–160-volt, 0–1500-ampère, direct-current separately excited booster, which is direct coupled to a 160 B.H.P., 500-Volt, light-compound, direct-current motor. There is also overhung on the shaft of the booster a 0–180-volt exciter which is separately excited through automatic control apparatus. The set runs at a speed of 750 r.p.m. and its nominal booster output is 1100 ampères at 75 volts. The machines composing it are all of the open type, and there are three pedestal bearings.

The direct and alternating-current switchgear for the auxiliaries throughout the station was supplied by the General Electric Company, Ltd. There is, first of all, a steel plate cubical switchboard for 400-volt, 50-cycle, alternating current, with direct-operated oil switches, the tanks of the latter being removable from the fronts of the cubicles. The board is divided into two halves, which stand some 12ft. apart, and are connected with copper bars in a sheet steel trunking under the ceiling of the room. One half of the board has the following cubicles:—One for a 1500 kVA incoming transformer circuit; one for the motor generator to supply the direct-current board; five for 400-volt alternating-current feeders for station auxiliaries; and one for interconnecting with the other half of the board. The latter is similar to the first half, but it has provision for six feeders and the interconnector cubicle has isolators only.

Secondly, there is a low-tension direct-current board which is also of the totally enclosed steel cubicle

FIG. 16—PUSH-BUTTON CONTROL PILLAR—G.E.C.

type, with instruments on the front and all "live" metal enclosed. This board has the following cubicles, reading from left to right:—One for the direct-current side of motor generator set No. 1; one for the 400-volt direct-current auxiliary circuits and isolator links for a 430 H.P. motor, this motor being for a circulating water pump; one set of cubicles for the battery, with automatic booster circuits; one for 400-volt direct-current auxiliary circuits and isolators for a second 430 H.P. motor; and one for the direct-current side of motor generator set No. 2. The automatic booster equipment is actuated by contactor apparatus. As explained above, the arrangements are such that the booster and battery gear take the direct-current load in the event of failure of the direct-current motor generator supply, and the battery is kept charged and floating on the bus-bars, while in the event of the booster breaking down, the battery is thrown directly across the bars. The starting and stopping of the booster are effected by push-buttons on the direct-current board.

When describing the circulating water pumps, reference was made to the two 430 H.P. direct-current Mather and Platt motors which operated them. The switchgear for operating these motors was also supplied by the General Electric Company, Ltd., the two panels on the switchboard just described being for the necessary instruments and apparatus. The speed of these motors is controlled by means of a motor-operated shunt regulator, and the starting and stopping, which are arranged for remote control, are effected by special push-button pillars, one of which is shown in Fig. 16.

In conclusion, we desire to express our thanks to Mr. Woodhouse and also to the various contractors concerned for the help which has been afforded to us in the preparation of these articles.

H

X-rays and the Crystalline Structure of Materials.*

By Sir WILLIAM H. BRAGG, K.B.E., F.R.S.

Introduction.—The examination of the structure of crystals by means of X-rays first became a possibility some fifteen years ago. Since that time the subject has been advanced by the work of a number of investigators who have been drawn to it in the hope that the new point of view might open up wide and important fields of knowledge which had hitherto been beyond the reach of inquiry. The resulting accessions to knowledge are described in several excellent and comprehensive treatises, which, however, can with difficulty keep pace with the rapid development of the subject because the method finds application in almost every branch of science. As the subject has a special bearing on the structures employed by mechanical engineers, I have thought that you might be willing to listen for a short time to an explanation of the principles on which it is based.

The Fine Structure of Materials.—The properties of any material depend, as we all know, upon its fine structure. No better example of the fact could be given than the growth of metallurgical science under the influence of the microscope. The toughness, hardness, brittleness, and other qualities of, let us say, a sample of steel vary enormously with the condition to which the steel is brought by work and heat. The microscope shows that the changes are marked by striking alterations in the appearance of the steel. The grains that are brought out by suitable etching show an infinite variety of forms which the expert has learnt to associate with a corresponding variety of qualities in the material. The fine structure thus displayed is obviously in close relation to quality.

But below the structure which the microscope makes clear is a much finer structure which no eye can see and no microscope will ever help the eye to see. In this realm of small things the lens of the microscope is constitutionally incapable of acting as an optical instrument.

Yet it is of the highest importance that the ultra-fine structure should be recognised and known; it is the real foundation of the properties of the body; that which the microscope reveals is merely a consequence of the other. The minutest grain of the microscopic photograph has a structure, and effective properties which depend upon it. How shall we reach this finer view and understand these more fundamental relations?

The Use of X-rays.—We must in the first place abandon the light waves that serve us in the study of grosser details, and use ether waves more fitted for the work. The lengths of light waves have only a small range of variation, but even within that range we have some guidance to the course we must take. The finer the details to be observed the shorter the waves that must be employed to be affected by them and to make them visible. In modern microscopy the shortest possible wavelengths, violet and ultra-violet, are employed in order to increase the power of recognising small things. When, on the other hand, we wish to avoid the scattering of light we use long waves, as when red flares are employed to penetrate a fog, and as infra-red rays have been used to obtain photographs through a scattering atmosphere.

But we wish to make a step hundreds of times as great as that between the two ends of the optical range; and we find the requisite quality in the extremely short other waves known as the X-rays. It is an extraordinary fact that the X-rays which are emitted by apparatus, such as we can conveniently construct and use, are ether waves of just the right length for our purpose. Had they been ten times longer or ten times shorter we should have been in very different case. The wavelengths are, in fact, of the same order as, but rather shorter than the dimensions of the fine structure we wish to examine, and this is exactly what we want. Whenever radiation—ether waves—is to be used to show the details of an object, it is essential that the waves shall not be larger than the details of the object examined, nor indeed as large.

Here, then, is our illumination of the right quality. How do we apply it? We are anxious to study those fine details on which the properties of substances depend, we have an ether radiation of the proper quality, what is the next step to be taken?

The Regularity of Natural Structures.—We take advantage of a certain strong tendency in nature for regularity of arrangement. The atoms of which a metal is composed are always found to be more or less in ordered array. One and the same pattern of arrangement may not, indeed, extend through the whole specimen; there may be breaks, on each side of which are arrangements that are similar but do not dovetail into each other. But whether the boundaries of any one array include a larger or smaller mass, regularity is always there. A portion throughout which the regularity is continuous is a single crystal; usually a mass of metal is an aggregate of minute crystals orientated in different directions.

The Diffraction Phenomenon.—Finally, and this is what makes the new analysis possible, whenever there are waves and regularity of spacing which is of the same order of magnitude as the length of the waves, there can result a certain measurable phenomenon called diffraction. The spacings of the striations of mother of pearl are of the same order as the lengths of light waves, hence the diffraction colours that play upon its surface. The diffraction effects observed on the grating spectrometer allow us to compare the wavelengths of light with the distance between two lines of the grating. In the same way there will certainly be some kind of diffraction effect when X-rays traverse a body in which there is regularity of arrangement. The usual wavelength of an X-ray is somewhere about the hundred-millionth of a centimetre, an Angstrom Unit, so called. The dimensions of the pattern on which the atoms and molecules of the solid are arranged are generally a few such units in magnitude; for example, the distance between the centres of two neighbouring atoms in a piece of aluminium is 2·86 A.U., and in α-iron 2·47 A.U., and in γ-iron 2·57 A.U. In these three cases the unit of pattern is very simple and consists of one atom only. In the majority of substances the unit is more complicated, and may contain ten, fifty, a hundred atoms. The regularity consists in the even spacing between a point representing one unit, and a point similarly representative of the next.

We have now got so far as to see that since there is regularity of spacing in a solid, and since the X-rays are of the proper length in comparison with that regularity, there ought to be diffraction effects of some kind; and if we can find them we ought to be able to compare the periodicity of the spacing in the solid with the wave lengths in the X-rays. If we can go on to find how that regularity depends on direction in the solid we should be able to lay out the details of the pattern. To take a very simple example, if we were told that the distance between the rows of vines in a vineyard was 10ft. in a north and south direction and the same east and west, but rather more than fourteen north-east and south-west, it would be easy to find the pattern of the planting.

Let us, then, try to see what sort of diffraction effect we might look for. In doing this, we must make use of the old principle of wave interference which Young in England and Fresnel in France developed in the earlier years of the nineteenth century.

Let us imagine a train of waves in the ether advancing and passing by an object that can scatter them. If we like to take the simplest case we can think of, we may say that the object is a single electron. A set of spherical waves will spread out in all directions in space concentric with the object which is their origin. Just so, a set of concentric ripples will spread out on the surface of a pond if a train of waves impinges on a post projecting above the surface. If we replace the single electron by some group of electrons, atoms and molecules, then in the immediate neighbourhood of that group there will be a jumble of interfering wavelets, but at some distance from the group the irregularities will have melted into each other and again there will be a system of spherical ether waves of which the group occupies the centre. We can observe this on the pond when the single post is replaced by a group of posts, which, it should be observed, need not be of the same size nor be spaced in any regular way.

The essential fact is that whether the scattering body be a single electron which we may look on as a point source, or a complicated group such as might be found within the compass of a single unit of pattern in the solid body, a train of secondary spherical waves will spread away into space from the point or the group. In the case of the group we must not look for a clear development of the spherical wave very close to its origin, but at a certain distance it will be well formed, and this is all that matters. The point and the complicated group give eventually similar results; and so we will for the present talk only of point sources or points.

What now will happen if there is a set of points arranged in any regular fashion or of groups which can be represented by points because they are all exactly alike? Here come in the principle of interference and its consequences. The application is made much easier by the fact that we have all seen it in operation under many different kinds of circumstances, and can therefore picture its extension to this case where imagination must take the place of actual vision.

Suppose, for example, we have a row of posts projecting above the surface of a pond, and let there be regularity to this extent that the posts are all in one line. Then each post becomes the centre of a train of spreading ripples, and what is to be noted is that these different trains combine to make linear ripples which recede, making a reflected train of ripples. The rest of the ripples from each post spread away in the usual fashion, dying out rapidly as they spread over a wider front. The combined wave front, on the other hand, is not only strong relative to the rest but persists for a far longer time. If the posts are many and are not too wide apart, the reflected ripples are the obvious parts of the phenomenon. In fact, the effect is often seen in a harbour where a row of closely planted piles reflects the oncoming waves. So also the air waves of sound are reflected by a row of palings. This is the one fundamental principle of the new analysis, extended to the case of three dimensions because we are now dealing with a number of points arranged regularly in space according to some pattern, instead of a row of posts in a straight line.

* * * *

If a pencil of X-rays having one definite wave length be caused to sweep through or over a crystal, say, of aluminium, it will be possible to turn the crystal into various positions until suddenly a reflected ray flashes out. When that occurs the pencil of X-rays makes a certain angle with the reflected ray, an angle depending as regards size upon the magnitude of a certain spacing in the crystal.

If a photographic plate is placed in the path of the reflected ray, two spots will be impressed upon it. One very strong spot made by the primary beam of X-rays and the other by the reflected beam.

The "Powder" Photograph.—Suppose the crystal were turned round about the axis of the X-ray pencil. The conditions for combination would not be affected, and if the X-rays were acting all the time, the spot cast by the reflected beam would be extended so as to form a circle on the plate with as centre the strong spot cast by the primary beam. To obtain this result, we must first set the crystal into a reflecting position and then rotate it about an axis coinciding accurately with the direction of the incident rays.

Now suppose that we use not a single crystal, but a small powdered mass of the substance. The vast majority of the crystalline fragments will not be in a position to reflect at all; but there will be some that are correctly adjusted and these will produce spots on the plate. Since among the reflecting crystals there will be some that take up all the possible orientations of the single crystal revolving round the axis of the X-ray pencil, the result will be the formation of a ring on the photographic plate. This effect is easily obtained. In fact, when we send a fine pencil of X-rays of definite wave length through a specimen of powdered aluminium, we find not only one ring, but several rings upon the plate.

* * * *

If any other crystal in a state of powder is treated in the same way, we find on the plate a set of rings which differs from that due to aluminium. Every substance has its own characteristic arrangement, because there are varying patterns according to which the points are arranged. Some of the patterns are particularly simple. The atoms of aluminium are packed together like a pile of cannon balls. As is easily discovered by trial, there are two ways of packing spheres closely together, one in which there is a repeat every third layer and one every second. Aluminium follows the former. The unit of pattern is very simple in this case, merely a single atom; so there are as many representative points as there are atoms. On this assumption we can calculate the diameters of rings which are characteristic of aluminium. The calculated system agrees perfectly with the experimental result. Whenever this system is observed aluminium is present, and no other body gives the same result. Aluminium is not the only metal of which the structure is that of closely packed spheres. At least fifteen others are built on the same plan—for example, calcium, γ-iron, nickel, copper, silver, gold, lead. In all these cases the rings are similar as regards their relative sizes, but the absolute sizes vary, because the atoms are not of the same diameter.

The Structure of Iron.—When we have a structure of different design the whole character of the system of rings changes. Photographs of α, β, and δ iron are quite different from that of γ-iron, which, as I have already said, is like that of aluminium. The disposition of the lines in these three materials shows that the atoms are arranged in a different way. If we put down a layer of spheres in a square pattern and on them a second layer, and on those again another layer exactly overlying the spheres in the first layer, and so on, we have the structure of ordinary iron.

Although iron undergoes a change in magnetic properties at 800 deg. Cent., there is no change in its crystalline structure. At 900 deg. there is a complete alteration in the design, the iron remaining non-magnetic. At 1400 deg. the structure reverts to its old form and the iron is magnetic again.

Some other metals, notably manganese, thallium and chromium, show similar changes from one form of structure to another.

Some metals like antimony, bismuth, and tin show much more complicated structures. Tin having one form of structure is brittle; having another form, it is not.

A Ring System Characteristic of Every Substance.—Not only does every different chemical element have, so to speak, its own signature, but every compound. Iron has its own ring pattern, carbon another; iron carbide has a pattern quite different again. A mechanical mixture of powdered nickel and powdered aluminium gives the systems of the two metals on the same plate; but the compound NiAl gives an entirely different picture. Every one of the hundreds of thousands of organic compounds has its characteristic X-ray photograph, though so many of them consist only of carbon, oxygen and hydrogen. It must also be observed that impurities do not affect the photograph. They may add other lines, if they are present in sufficient quantity, but they do not affect the position or sharpness or intensity of the lines proper.

The opportunities thus offered have tempted

* The Institution of Mechanical Engineers. Fourteenth Thomas Hawksley Lecture, November 4th, 1927—abridged.

observers to follow the nature of alloys, through all their various ranges of composition. The technique is difficult, and interpretation is hindered by present inexperience, but remarkable results have already been obtained.

* * * *

There is one very remarkable feature in certain of the metal alloys, namely, the very large number of atoms in the unit of pattern. As an example, I may take the case of ß bronze, which has been examined by Bernal in the Davy Faraday Laboratories of the Royal Institution. The unit cell contains more than a hundred atoms; clearly the atoms of copper and tin have definite and unyielding characteristics; a careful adjustment of a number of each kind is required to complete one unit before starting another. Even a pure metal sometimes shows a similar character. The ordinary form of manganese has fifty-six atoms in the cubic cell, according to Westgren and Phragmen.

The ring pictures which I have tried to explain are obtained when a powdered mass of the crystalline material is traversed by the X-rays. The completeness of the ring is ensured by the complete disorder of the fragments of crystal. They must be orientated in every possible way. If this is not the case, the completeness of the ring suffers; only parts of the circles appear on the photograph.

The Effect of Treatment on the Form of the Rings.—Now if the metal experiences any mechanical treatment, the particles are put into partial order. Therefore any such treatment will alter the appearance of the photograph because the rings can no longer be complete. The rings will remain, but they shrink into spots on the circumferences. Faint radial lines appear due to inhomogeneities in the X-rays, which were not apparent in the simple picture because they were diffused all round the compass. The skilled observer learns to interpret the effects observed; and much useful information has already been gained.

The Rotation Photograph.—A powder gives complete rings. If the powder is combed out by any treatment the rings shrink into short arcs. We may understand this better by beginning at the other end. Let us take the case of a single crystal, subjected to monochromatic X-rays. We have seen that unless it is correctly held there is no reflected ray. It must be disposed so that some plane of points in the crystal makes the proper angle with the X-rays and then the reflection flashes out. There are several such positions, in each of which one of the many planes which can be drawn to include the representative points in the crystal is prominently involved. But it is not likely that any chance holding of the crystal will give a reflection. Suppose, however, that the crystal is made to revolve about an axis perpendicular to the X-rays. The inclination of the rays to the various planes will change continuously over wide ranges during the revolution, and reflection after reflection will flash out as each set of planes, and therefore each reflected ray makes its own characteristic angle with the incident beam. The resulting photograph will show a collection of spots, and we may well expect that the ordered array in the crystal will give order to the photographs.

The "Fibre" Photograph.—Suppose now that instead of taking a single crystal and rotating it, we were to take a number of minute crystals arranged so that some one common direction in them all was parallel to a certain straight line and perpendicular to the X-ray beam, but otherwise their disposition was a matter of chance. The substance might be said to possess a "fibre" structure. We should then expect the same picture as when we rotated the single crystal. In the first case, one crystal occupied all possible positions successively; in the second case, different crystals occupied all possible positions at the same time. A good example is given by a set of asbestos fibres, each of which is crystalline. One definite direction in each crystal is parallel to the length of the fibre and the bundle of fibres is placed perpendicularly to the X-rays.

It will now be clear that the photographs of mechanically treated metals have an appearance somewhat similar to that of asbestos. In them also, we must conclude, the separate crystals are arranged so that some one direction is perpendicular to the X-rays. When the circles shrink into spots or short arcs, it is because the substances show a certain amount of "fibre." The picture is symmetrical, if the angle of inclination is a right angle.

Now the extent of development of fibre structure, the magnitude of the crystals, and their orientation to the direction in which strain is to be expected are extremely important things. Fibre structure does not alone determine the strength and other properties of a specimen, but it is one of the most important of the influences that do so. It is one of the most obvious of the applications of X-rays to observe the changes in fibre structure due to the preparation of a specimen, and its subsequent mechanical treatment and annealing.

* * * *

Summary.—I have tried to sketch the fundamental principles of a new method of examining the structures of nature. Its importance lies in its application to a range of dimensions where the properties of the structures are mainly formed; dimensions somewhat larger than those of atoms and molecules, much smaller than those which are observed under the microscope. Since both method and application are so new, we might legitimately say that we have here a new science. It is a science which has links with every other, for it is not only in the case of metals, though I have referred to metals in the main, that X-rays show us processes of which otherwise we should know nothing. All the other substances which the engineer handles—wood and stone, bricks and cements, conductors and insulators, lubricating oils, and a host of other things—have structures on which their properties depend. The same may be said of the cottons, wools, and other fibres of the textile worker; of the living substances with which the physiologist deals; of the botanist's plants, the geologist's minerals, and indeed all the solid substances that are handled by man. It would be false modesty to refrain from claiming the power which the X-rays give us of entering upon this huge field. We must pay our debt to modesty when we admit our present inexperience in handling our new power, our lack of understanding all that our observations tell us, our want of realisation of what we may now attempt, and the deficiencies in our technique. However, the number of workers is already so great and grows with such increasing rapidity that not only will the foundation of our new science be rapidly strengthend and broadened, but also the superstructure will rise quickly. I am glad to say that in this country an official entry into the new field has been made by the foundation of a department at the National Physical Laboratory, which is to take as its special concern the application of X-ray methods to industrial problems. The private laboratories of this country which have been interested in the subject should be mainly devoted to the fundamental principles and to applications in pure science. It would, indeed, be a mistake to concentrate all our energies on industrial applications while we have still to map out the main features of the subject. It will happen here, as it has happened with every new increase of knowledge, that many of the first suggested applications will fall short of what is hoped, and that the great successes will come from directions unexpected. Moreover, the benefit which will come from the widening of outlook and the general strengthening of our knowledge of structure will be of greater importance than the special and limited applications which we think we can put in hand at once, useful and fascinating as these may be. Therefore, I hope you will wish success both to the new venture at the National Physical Laboratory and to the more general investigations that are now in progress elsewhere.

SIX-CYLINDER DOUBLE DECK OMNIBUS

LEYLAND MOTORS, LTD., LEYLAND, ENGINEERS

A New Six-cylinder Motor Omnibus.

After eighteen months' experimental work, Leyland Motors, Ltd., has put into production a new range of public service vehicles propelled by six-cylinder engines. These vehicles are of entirely new design, and a single and double-deck omnibus of the new type will be on view at the forthcoming Exhibition at Olympia, together with this firm's well-known four-cylinder "Lion" type vehicles, which will still continue to be the main products. For most classes of work the four-cylinder vehicles leave nothing to be desired, but the Leyland Company considers that there is also a wide field to be developed in connection with super-passenger omnibuses for long-distance work, and it is probable, in that branch of transport, that the six-cylinder vehicles will find a market. We give herewith some views illustrative of these new products which we have had an opportunity of inspecting and testing at the company's works at Leyland, Lancashire. They consist of single-deck omnibuses seating thirty-two to thirty-nine passengers, which will be known as "Tigers," double-deck vehicles accommodating fifty-one people, which will be known as "Titans," and a double-decked covered-top omnibus to carry seventy-two passengers on a rigid six-wheeled chassis, called "Titanics." By reason of the great engine power—105 horse-power at 2000 r.p.m.—combined with the light weight of the chassis and excellent spring suspension, the running of these vehicles resembles that of the highest class of private automobile as regards speed, acceleration, and absence of noise and vibration.

The main features of these vehicles are:—A six-cylinder engine; engine and transmission situated off the centre of the chassis; unit power plant construction; and extremely large section, low-level frame with tubular cross members. Two important advantages are gained by off-centring the engine and rear axle drive. The off-centred engine allows the driver's cab in the side type vehicle to be more spacious, permits of the change-speed box and lever being mounted directly on the crank case, and gives a straight-line connection from the change speed lever to the gear-box, resulting in considerably easier change speed operation. Off-centring the engine also gives sufficient space for the engine to be lifted out of the chassis frame without disturbing any part of the driver's cab. The off-centring of the axle worm pot permits the floor level of the omnibus to be lowered some 5in., the axle pot coming up under one of the passenger seats and allowing the gangway to be carried straight through without ramps or obstructions.

The engine is an entirely new design of the modern high-compression type. Its speed range is remarkable, and it has an exceptional low-speed torque, pulling smoothly at speeds as low as 200 r.p.m., while it runs up to 2500 r.p.m., a range which gives a top gear performance of 3 to 50 m.p.h. It has a bore 4in. by 5½in. stroke, which represents a capacity of 414 cubic inches and an R.A.C. rating of 38·4. Its maximum power of 105 horse-power at 2000 r.p.m. is obtained with the standard road setting and with a consumption of 0·6 pint per horse-power hour.

As will be observed from the illustrations, the engine is so designed that all accessories and those parts requiring accessibility, except the plugs, are on the near side of the engine, this feature being essential for side type omnibuses, in which the offside of the engine is masked by the driver's cab.

An overhead cam shaft and overhead valves have been adopted. The cam shaft rotates in the deep trough in the cylinder head well below the surface of the joint, and is lubricated by a continuous flow of oil passing down the trough. The cams and rocker ends always being partially submerged in oil, are very quiet in operation and subject to a minimum of wear. The valve cover is removed by three hand screws, and adjustment of the valve clearances can then be made without interfering with any other parts of the engine. All valves are completely water cooled around the valve seats. The cylinder head is readily detachable, all the nuts being easily accessible. Special flanged nuts are placed at each end of the head so as to break the joint, and a lifting hook for raising the head is fixed in the roof of the driver's cab. A pulley block is provided with the tool kit for lifting both cylinder head and cylinder block. The detachable head permits of all valves to be ground in on the bench.

It will be noted from the sectional view of the engine that the flame from the sparking plugs is carried through a small port to a central position in the cylinder head, so as to give the best possible ignition position. This arrangement prevents the sparking plugs becoming overheated, and also prevents any possibility of the plug points becoming oiled up.

The crank shaft is of very robust construction, with seven main bearings, 2¾in. diameter, having a total bearing area of 75·6 square inches, and is of such stiffness as entirely to eliminate crank shaft vibration throughout its speed range. It is machined all over and dynamically balanced. The crank pins are bored out for lightness. The crank case is an aluminium casting, all the bearings being rigidly webbed, while the horizontal joint flanges are specially extended to give lateral stiffness. The main bearing bolts are carried right through the

cylinder, so that cylinder loads are transferred direct to the main bearings without any crank case distortion. All the main bearing caps are provided with steel support bars and are registered into the crank case to give proper location. The crank case is mounted by a three-point suspension so that it may not be affected by chassis distortion. The bottom half of the crank case is provided with two large inspection covers, through which connecting-rods and pistons can be removed, and the oil filter cast and machined opposite each cam so as to provide a separate oil well for each cam to dip into. An oil pipe directs a jet of oil on to the timing chain and gears. The oil pressure can be adjusted by screwing an external control rod to the throttle pedal. A large gauze box type of strainer is mounted in the sump, where it is easily detachable for cleaning. In addition to it, a patented form of felt strainer is mounted on the front crank case cover plate so that it can be easily removed and cleansed, as shown in one of the illustrations. This felt strainer is for taking out the minutely small particles of carbon and other foreign matter from the oil, the oil passing through a 1in. thickness of closely woven felt. The operation of this filter is entirely independent of the main lubricating system, the oil being supplied to it by means of gravity from a funnel cast in the upper portion of the crank case. The oil is brought by means of drilled holes to the underside of the felt, whence it percolates through the felt and is returned thence by drilled holes in the crank shaft to all the connecting-rods. A unique feature of the system is that the oil pressure relief valve is coupled up to the throttle pedal, so that the oil pressure is varied according to the requirements of the engine, that is, when the engine is working at full throttle the pressure rises to 70 lb., while when it is idling it is reduced to about 5 lb. The main oil pump has a capacity of 7 gallons per minute at 2000 r.p.m., and the sump has a capacity of 3¼ gallons. A secondary oil pump integral with the main pump delivers a separate quantity of oil through a cored passage to the cylinder head, the oil flowing thence by gravity down the cam shaft trough to the crank case at the rear end. Small obstructions are to the oil sump. Being entirely independent of the pressure lubricating system, this filter does not affect the oil pressure. It is found by experiment that about 1 gallon an hour passes through the felt, with the result that the whole of the oil will pass through the strainer three or four times per day.

The timing gears and fan are driven by means of a duplex roller chain, the same chain also driving all the engine accessories. The final drive to the cam shaft is by means of helical gears, so that the chain need not be broken when the head is removed. The chain drive to the fan is claimed to eliminate entirely the usual fan belt trouble, the fan being mounted on a slipping clutch to act as a damper. All the timing gears are mounted on ball bearings with special oil seals to prevent leakage. The timing chain is kept at proper adjustment by an automatic tension device, so that the adjustment of the chain requires no attention.

It should be noted that the helical gear pinion on the fan spindle is split, and springs are so arranged as to take out any backlash in the gear teeth. The gear teeth are cut extra deep in order to allow for variations in centres, due to slight variations in thickness of the cylinder head gasket.

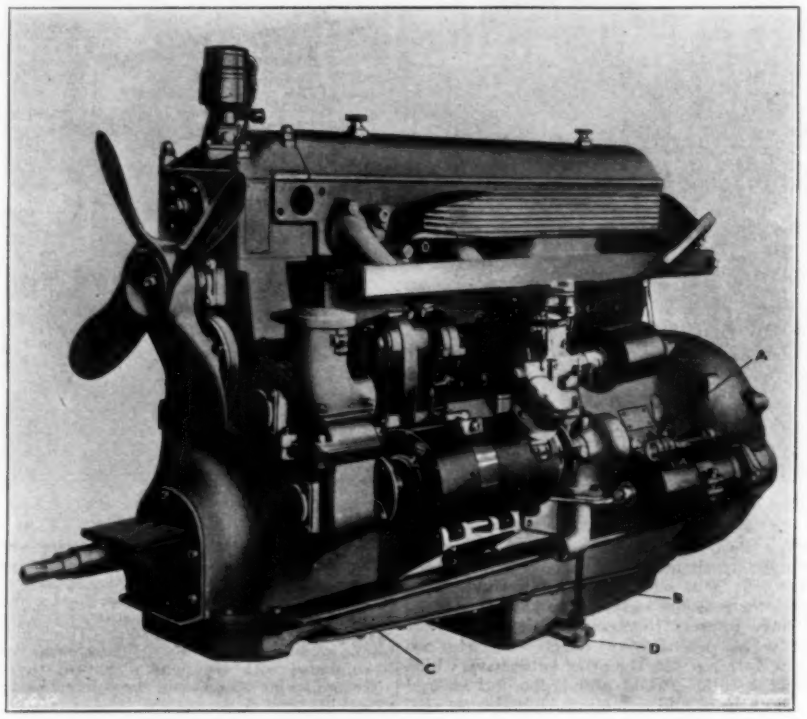
The water pump is mounted behind the generator in an easily accessible position, so that the gland can be easily packed without removal. The pump is driven by a twin disc flexible coupling, so as to ensure that any misalignment will not cause a bearing pressure on the gland which might result in leakage or wear.

Ignition is alternatively by a coil and distributor or by magneto. Automatic advance is arranged for both ignition systems, so as to eliminate the driver's control on the ignition setting, manual control being provided for adjustment only.

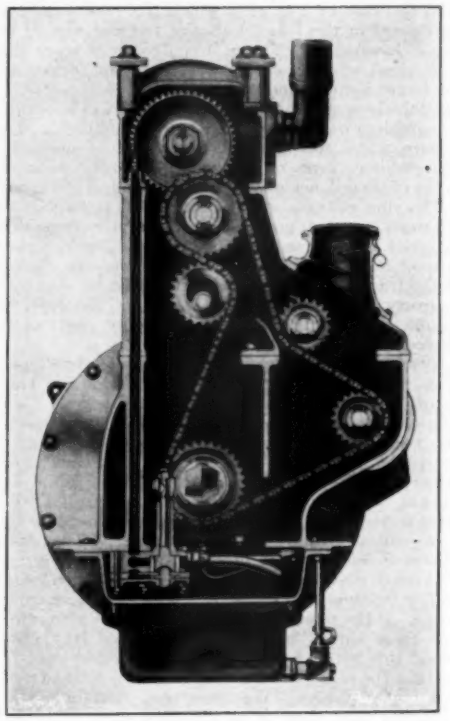
The automatic device for controlling the ignition has been most carefully developed, so that the correct ignition advance may be obtained for all speeds of the engine.

The manifold fitted to this engine has been arrived at after considerable experimental work with its pipe arrangements. A hot spot from the exhaust manifold is arranged immediately above the carburetter, and it gives sufficient heat completely to vaporise the fuel.

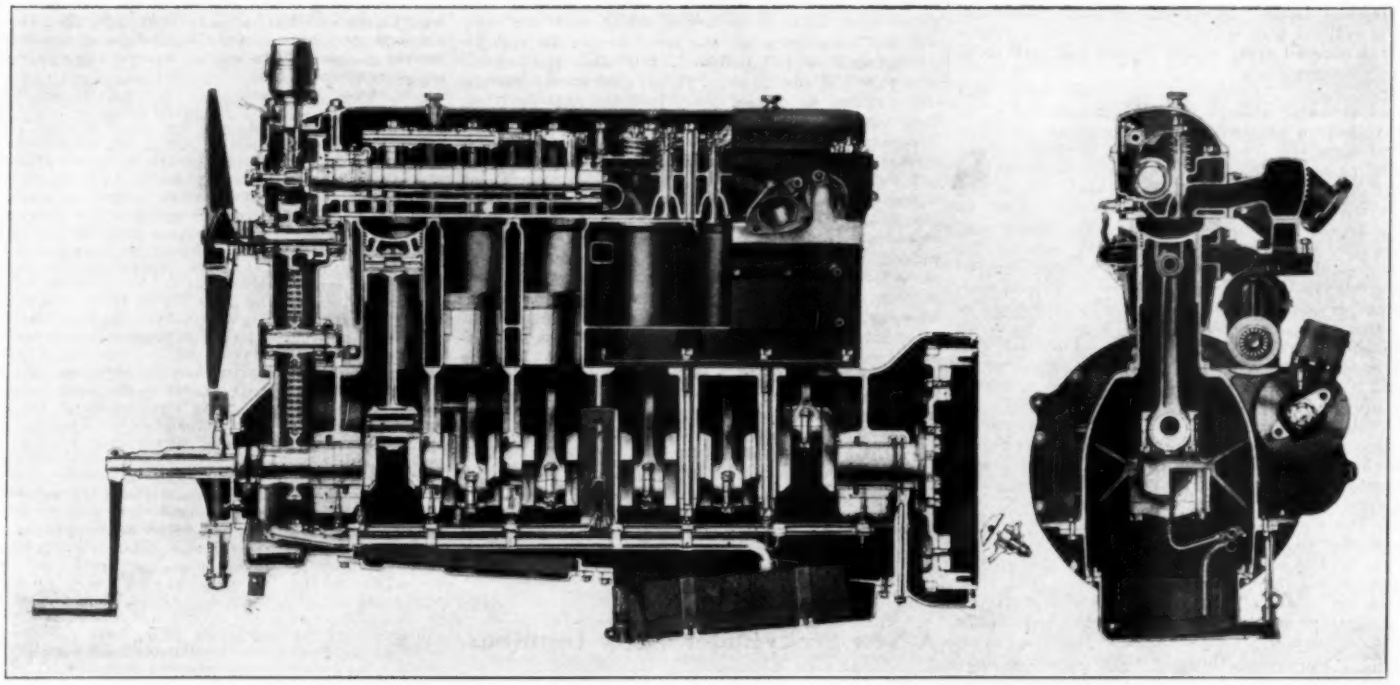
A special feature of the radiator is that it is mounted at a single point at the centre of the bottom tank on a rubber



AUXILIARY SIDE OF LEYLAND SIX-CYLINDER ENGINE



TIMING GEAR DRIVE



SECTIONS OF LEYLAND SIX-CYLINDER 105 H.P. OMNIBUS ENGINE

block on the front of the engine, and fixed by two studs to the cylinder head. This method of mounting isolates the radiator from the relative movement of the two frame side members, and makes the radiator a single unit with the engine.

The single plate clutch is mounted entirely on ball bearings in the engine bell housing. It is so arranged that no internal adjustment is required throughout the life of the clutch liner, the clutch pedal being adjustable for height by means of a brass wing nut through a trap door in the driver's floor-boards. The clutch disc is a single fabric plate, and as no steel disc is required the clutch is extremely light and permits of very easy speed changing. The leverage is so arranged that extremely light pedal pressures need be used, the operation of the clutch being as easy as that of a private car. The clutch withdrawal ball thrust and housing do not rotate whilst the clutch is engaged, so that no parts of the clutch or clutch bearings are subject to wear whilst the clutch is engaged, an arrangement which considerably prolongs the life of the clutch.

The four-speed gear-box has shafts 2½in. diameter, while the gears are as wide as 1¼in. on the face. The sliding shaft is case-hardened and ground all over the splines. The box is supported direct from the bell housing in the engine, so as to ensure that it is correctly in line and do away with intermediate couplings and propeller shaft. All the gears are of case-hardened alloy steel. The ratios are as follows:—Fourth, 1 to 1; third, 1·6 to 1; second, 2·77 to 1; first, 4·42 to 1; reverse, 5·16 to 1. All gears are 6 d.p. 20 deg. pressure angle. The distance between the bearings in the spline shaft is only 11$\frac{1}{16}$in., and the lay shafts 12$\frac{11}{16}$in., the gear centres being 5in. A drive for the speedometer is incorporated in the gear-box by means of spiral gears, and a leather oil seal is mounted over the rear bearings to prevent oil leakage. A large inspection cover is arranged on the near side of the gear-box, and the whole of the selector and change-speed mechanism can be removed from the offside of the box without disturbing the gears or shafts.

On the bonnetted chassis a central ball mounted change-speed lever is fixed direct on the gear-box. On the side type machine a patented form of change-speed control is mounted directly on the crank case on the left-hand side of the driver. The change-speed gear is entirely enclosed in an oil-tight aluminium box, and the operation of the gear-box is through the single shaft, which is caused to rotate for selecting the gears and to reciprocate for changing speed. This shaft runs in spherical bearings, so as to get over any difficulty there may be in difference of alignment between the change-speed mechanism and the gear-box.

Special care has been taken in developing the braking system, with a view to obtaining a silent and smooth operation, and at the same time retarding the vehicle easily and quickly. There are six sets of two-shoe brakes, all of them being mounted directly in the road wheels and not on the transmission. Two sets of shoes are mounted on the front axle and four sets of shoes on the rear axle. The foot brake operates on all four wheels, and is servo-operated on the Dewandre principle. The hand brake operates on a separate set of shoes on the rear axle. All compensating gear between the brakes has been done away with, and should any part of the brake mechanism on one set of the shoes fail the other five sets of shoes can still be operated. Both hand and foot brakes can be adjusted from the driver's seat.

The rear axle is of the underslung worm driven type, the axle pot being, as explained above, off-centred so as to give a low floor level in the central aisle of the vehicle body. The driving and braking forces from the axle are taken through the road springs.

Torque tube construction has been discarded, having regard to the necessity for reducing the total weight of the chassis, improving the accessibility of the couplings, increasing the ease with which the axle can be removed and the cushioning effect of the spring drive. A semi-floating axle shaft construction has been used, as it permits of the hubs and brake drums being removed without disturbing or exposing the wheel bearings. The axle casing is made from a one-piece nickel steel forging, with spring carriers and brake mountings hydraulically pressed on each end. The worm carrier is an aluminium casting having an exceptionally large oil capacity, the normal capacity being 2½ gallons, and oil seals are used to prevent oil leakage on to the brakes. Three cup leather seals, spring loaded, are fitted on each of the axle shafts. In addition to this, an oil catcher is so arranged on the hub that all oil leakage passes through holes to the outside of the hub, and cannot get to the brake drums. A long stuffing-box, packed with special sections of graphite packing, is placed at the front end of the worm. Both worm and wheel are mounted on roller bearings, the worm wheel bearings being adjustable sideways, so that the correct marking can be obtained on the worm gear when mounting. The axle ratios are as follows:—For single-deck omnibuses, 5·5 to 1; for double-deck omnibuses, 6·5 to 1.

The chassis frame is of deep section. The maximum section is 11in. by 3½in. The frame is swept up at the front and over the rear axle, which allows of a very low floor level, the top of the frame being only 1ft. 10in. from the ground, laden. The cross members are constructed from 4in. diameter tubes, pressed into flanged castings, which are riveted to the side members. These tubular cross members provide a rigid frame construction, and are said absolutely to ensure that both side members of the frame are kept parallel with each other under all conditions.

The propeller shaft is 3in. diameter, light gauge tube, and is dynamically balanced to prevent whirling or vibration at high speeds. The propeller shaft has a central bearing with a spherical mounting, so as to allow for any misalignment that may occur on assembly. This bearing has a large oil capacity, and cup leather seals held tight to the shaft by means of coil springs are used to prevent oil leakage. It is connected to the central chassis lubricating system.

The tires are of the balloon type, 38in. by 8½in., and an air pressure of only 45 lb. per square inch is used, so that riding is wonderfully easy. For double-deck vehicles 36in. by 8in. high-pressure tires, 95 lb. per square inch, are fitted on the front axle and 34in. by 7in. twin high-pressure tires on the rear axle.

The inside of the omnibus is warmed by by-passing the exhaust gas through a 2in. weldless steel pipe on both sides of the body interior. The heat is controlled by means of a by-pass valve operated by lever under one of the seats.

The lubrication of the various parts of the chassis is performed by the Tecalemit principle with batteries of nipples disposed in accessible positions.

The front axle is of entirely new design. It embodies an improved form of front wheel brake, a new type of steering rod end and a new type of roller thrust race. All parts on it, including the steering rod ends, the king pins, the brake mechanism, &c., are lubricated by the Tecalemit system. The main axle beam is of heavy section, and its overall dimensions are 3½in. by 2½in. It is made from a high carbon nickel steel heat-treated forging. A nickel steel swivel axle of unusually heavy design—the spindle being 2¼in. diameter—and unusually large taper roller bearings are used. A new type of axle nut, which gives extremely fine adjustment to the wheel bearings, with a positive lock to the nut, has been used.

Large bearing areas are provided for the king pin, these bearings being 1¾in. and 2in., and made from hardened steel or bronze, and there is an entirely new design of thrust race mounted on a spherical base. The rollers in this race, being horizontal, take the load without wedging action or tendency to pit the races.

The brake-oprating mechanism is actuated by a vertical push rod through the centre of the king pin, so as to eliminate the usual defect of the brakes tending to come on on one side when steering at full lock. It will be noted that on this front axle the brake operating mechanism and king pin bearings are completely enclosed and protected from dirt.

In the event of the front hub being overcharged with grease, with the result that there is leakage of grease from the inside of the hub, overflow is carried by oil catchers through holes to the outside of the hub, to prevent any of the grease getting on to the brake drums.

The front wheel brakes are normally adjustable, together with the rear brakes, by a single wing nut under the driver's seat, but individual adjustment of the front wheel brakes can also be effected by a setscrew accessibly mounted on the brake cam shaft.

It is somewhat difficult to obtain really easy steering with low-pressure balloon tires, owing to the big area in contact with the ground. This difficulty, however, has, the makers claim, been overcome in the design of this front axle and steering gear. The projected centre of the king pin goes almost to the centre of the tire at the ground contact point, and great care has been given in getting the correct castor angle.

The steering gear is of the worm and segment type having low ratio worm gears, the gears being spaced with large centres. The centres of the gears are adjustable by means of an excentric bush to take up wear, the bearings being lubricated on the "one shot" lubricating system. The steering-box is rigidly mounted on the front frame cross tube, and is so arranged that it can be swivelled round that tube to allow slight variations of steering column angle.

The mounting of the steering is so rigid that no other steady for the steering column is necessary, there being no body connection for the steering gear on the side type machines.

Springs of great flexibility are used, the rear spring having a total of 9in. motion from the position of completely unladen spring to the shock position when the rubber bumper comes in contact with the frame, the corresponding figure for the front spring being 6in. Deep section rubber bumpers are placed above the front and rear axle, and they allow of ½in. compression, so as to prevent harm being done to the axles or frame in the case of excessive overload or very bad roads.

All road springs are made from chrome vanadium steel, 3½in. wide, the front spring being 3ft. 8in. long and the rear spring 5ft. long. Exceptionally large diameter shackle pins are used, the same sized pin being used at all twelve points. The spring ends taking the braking or driving loads are of the solid forged type. A special feature of the design is that wear on the sides of the springs and frame brackets and shackles can be taken up by a screw adjustment. This is an important feature, inasmuch as excessive side slop in the springs not only tends to cause noise, but it also permits water and dirt to enter the shackle bearings. The shackles for the front springs are placed at the front end. This design permits of less lost motion in the case of the front wheel brakes, and very much improved steering in the case of bonnetted machines, and makes the shackles somewhat more accessible.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

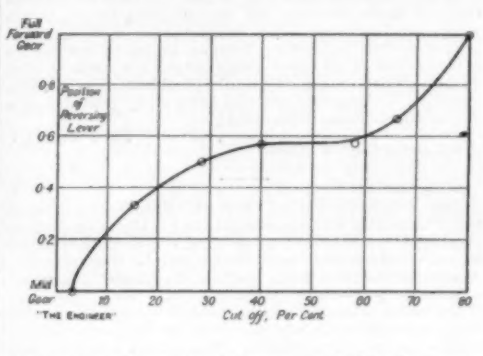
BRITISH LOCOMOTIVE DESIGN.

SIR,—As a student of engineering, whose knowledge is at present mainly theoretical, I have been much interested in the correspondence on "British Locomotive Design," which has been running for the last two months in your journal. It is therefore rather confusing to find that the experts on the subject entirely fail to agree on very many vital points. For example, Mr. C. R. King, on pages 423 and 478, repeatedly states that no locomotive, compound or simple, should ever have a cut-off earlier than 30-35 per cent.; on the other hand, Mr. Riekie, on pages 367 and 449, says that his compound locomotive should never cut-off later than 25 per cent. in the high-pressure cylinders (except for the first few revolutions at starting). Again, on page 349, Mr. Keiller states that compound locomotives weigh more than simple engines doing the same work; while Mr. Thompson (page 367) declares that compound engines are used abroad in order to get an economical engine with a light axle load. In this second example, perhaps the explanation is that these gentlemen are referring to particular designs—might I suggest that they bring forward general figures to support their cases?

In fact, on the question of compound locomotives as a whole, opinions seem to be very divided—I need not quote further cases of disagreement. Mr. Riekie's design for a compound is one of the most interesting of recent years, especially as I understand that it is backed up by experience of a similar locomotive in India.

When Mr. Riekie's modification of the Walschaerts valve gear (referred to in his letter on page 449) was described in the *Locomotive Magazine* in September, 1926, I was sufficiently interested to draw out the valve ovals for this gear for different positions of the block in the link. I assumed steam lap = 1$\frac{1}{16}$in., lead = $\frac{1}{16}$in., exhaust lap = nil, maximum valve travel = 6in. While these may not be the best dimensions possible, they give one an idea of the characteristics of the gear. From these diagrams, I can understand that, for Mr. Riekie's "treble" compound locomotive, no more suitable gear could be devised. A late exhaust closure, and consequent minimal compression is given at very early cut-offs (at 15 per cent. he obtains 83 per cent. closure to exhaust); furthermore, the cut-offs obtainable are exactly those postulated by Mr. Riekie for the most efficient working of his engine. I have plotted, on the enclosed curve, the position of the block in the link against cut-off given by the valve. It will be seen that cut-offs of 80 per cent. to 60 per cent. are available for starting purposes, and of 3 per cent. to 35 per cent. for running conditions. The intermediate range, from 35 per cent. to 60 per cent. is indeterminate, the valve pausing during its travel just on the edge of the steam port, so that the slightest displacement either way will make all the difference between 35 per cent. and 60 per cent. cut-offs. Consequently I should imagine that Mr. Riekie's gear would not be very suitable for simple engines, especially those worked as recommended by Mr. C. R. King.

There is just one emendation that I would suggest to Mr. Riekie's unorthodox compound design, and that is the provision of two large size double-beat poppet valves at each end of the 42in. low-pressure cylinder, instead of the cumbrous expedient adopted



of having two valve chests, with consequent double oil consumption, double weight, and double friction and wear. The valves could be worked by cams on the Lentz system, the cam shaft being driven from the original loose excentric.

Mr. Riekie states on page 449 that his engine develops greater power than the Baldwin compound 4–10–2, No. 60,000. Now his engine has two 20in. diameter by 26in. stroke high-pressure cylinders, which develop their maximum tractive force, and hence their maximum power at 25 per cent. cut-off. Let us consider his engine operating under the same conditions as the Baldwin locomotive, *i.e.*, at the same number of revolutions per minute, and with the same steam supply (350 lb. per square inch gauge, superheat 200 deg. Fah.), and assume a clearance of 20 per cent., all of which is to be filled with steam each stroke. Then the total cylinder volume open to steam per revolution of the driving wheels is:—$4 \times (20 \text{ per cent.} + 25 \text{ per cent.}) \times \frac{\pi}{4} (20)^2 \times 26 = 14{,}700$ cubic inches. The Baldwin engine, on the other hand, has 12½ per cent. clearance, and develops its maximum power at 80 per cent. cut-off in one 27in. diameter by 32in. stroke high-pressure cylinder; the corresponding volume per revolution is $2 \times (12\frac{1}{2} \text{ per cent.} + 80 \text{ per cent.}) \times \frac{\pi}{4} (27)^2 \times 32 = 33{,}900$ cubic inches.

Now the steam consumption of No. 60,000 is, on the average, 15 lb. steam per I.H.P.-hour (see tests Nos. 7906–7930 at Altoona, 1926), with 16·6 lb. as a maximum. Assuming 17 lb. for our argument, we see that, to develop equal power, Mr. Riekie's engine would have to use: $\frac{14{,}700}{33{,}900} \times 17 = 7{\cdot}4$ lb. steam per I.H.P. hour. As this gives a thermal efficiency of 26·0 per cent., it appears that Mr. Riekie has made a notable step forward in locomotive design.

Since writing the above, I have seen the latest number of THE ENGINEER (November 4th), and Mr. Keiller's letter therein. I find that he states very concisely many of the arguments that I had intended to bring forward against Mr. C. R. King's "up-to-date" theories of steam expansion. I will therefore not waste your valuable space by useless elaboration; I would just mention that I have inquired at several booksellers for Mr. King's "New Steam Tables of M.E.P." (mentioned in his letter on page 478), in order to keep myself abreast of the latest developments in the theory of heat engines, and I have invariably been informed that they can find no reference to such a book in any of their catalogues.

C. E. P.

Cambridge, November 5th.

RECENT BRITISH LOCOMOTIVES.

SIR,—In your issue dated October 8th, Mr. Charles King treated us to another very interesting, but rather involved letter, on the respective merits of simple and compound locomotives.

One gathers, but somewhat indefinitely, that he prefers compounds to simples, and that he believes that saturated steam gives better results than superheated steam. As the advantages of the latter have been proved, over and over again to be beyond dispute, no purpose can be served in arguing to the contrary.

If, as he says, there is no advantage—in fact, a distinct disadvantage—in working single expansion engines with an early cut-off, surely this amounts to one of the strongest arguments in favour of compounding that can be advanced. According to Mr. King, the high-pressure cylinders of a compound, since they correspond with those of a simple engine, should be operated with a more or less late cut-off; and the low-pressure cylinders with an earlier cut-off. The steam from the former, with plenty of expansion left in it being used over again in the latter cylinders, in contradistinction to being, as in the case of the simple engines, turned direct into the chimney and wasted.

It is well known to railway engineers that there are two methods of using the steam in the cylinders of a locomotive,

namely :—(*a*) Linking-up the reversing gear so as to give as early a cut-off as practicable ; and (*b*) cutting off the steam later in the stroke ; the opening of the regulator in both cases being varied to suit the work to be done. With the first mentioned method, the steam chest pressure is often nearly equal to that of the boiler, and the required power is adjusted through the medium of the regulator ; while, with the alternative method, the steam chest carries a much lower pressure, and the power output is also governed by means of the regulator. Of course, under certain conditions of load, speed, and gradient, it might be possible to run with the regulator fully open for a time. In so far as my own lengthy experience in India was concerned, I always found that the drivers who worked their engines by method (*a*) were those who came out lightest in coal consumption, and they were those who earned the coal premiums. On the other hand, the men who operated their engines with a late cut-off were invariably at the foot of the coal sheets, some of the men, indeed, as compared with others, showing increased consumption of 60 per cent. Such, at any rate, was my common experience abroad, though I have since heard that on some English railways there has been no great difference in coal consumption as between engines driven by the one method or the other.

The statement that notching-up causes a certain amount of negative work is no doubt true, the difficulty being to get the steam out of the cylinders rather than into them. But is not this state of affairs partly due to imperfections in the valve gear employed ? The long valve travel affords some relief from excessive back-pressure, and by doing so lessens, of course, the amount of negative work on the pistons at high speed, and thus enables a better diagram to be obtained. Further, a comparatively short cut-off can be employed.

Even so, it would appear that no legitimate case has yet been made out against the compound locomotive, for the very important reason that the question of the extra power which, I contend, is possible with compounding (by using the expansive properties of the steam in an additional cylinder, or pair of cylinders, preferably the former) is in no way ruled out ; this increase in power, according to continental practice, being easily realisable on a very moderate steam consumption.

JOHN RIEKIE.

November 7th.

SIR,—Whether or not Mr. Charles R. King has put the extra power obtainable with compounding at too high a figure, I am glad, nevertheless, to see that Mr. C. M. Keiller virtually admits that it is possible to get an increase in tractive effort of at least 30 per cent., which is surely a sufficiently substantial difference to make compounding worth while.

Mr. Keiller is under a misapprehension, however, as to there being any difficulty in supplying steam for the compound locomotive suggested in my letter, which appeared in your issue of the 21st ultimo. It will be remembered that the two high-pressure cylinders were to be 20in. in diameter, and seeing that we have simple 4–6–2's running with three cylinders of that size, it is obvious that no trouble would be experienced on the score of providing a boiler of adequate steaming capacity for the compound in question, more especially as the engine would normally be worked—on my system—with a maximum cut-off of 25 per cent., except at starting.

As regards the use of a loose excentric for driving the low-pressure valve, I personally always found this to answer the purpose admirably, and although I myself prefer it, anyone who objected to it could easily employ ordinary valve gear in its place. The low-pressure valve should not be linked up at all, the steam thus being free to expand fully and unrestrictedly. Another of your correspondents, Mr. William Donald (October 28th) is entirely in error in assuming that "compound cylinders would not give the force of the exhaust steam from the low-pressure cylinders that would create the suction in the smoke-box that is required for coal-fired furnaces." The successful working of the present-day French compounds clearly proves that the exhaust from the low-pressure cylinders for the proper combustion of coal, and for maintaining the necessary steam pressure for the hauling of loads of from 500 tons to 600 tons behind the tender, is of ample force. Other things being equal, there is no virtue whatever in a heavy blast, the problem being to prevent too much, rather than too little, air being drawn into the fire-box by the action of the exhaust.

Compounding helps in this direction by softening the beat, but it is a mistake to suppose that this effect is a disadvantage even in the case of simple locomotives. The idea is to reduce the intensity of the draught as much as possible. Finally, two and three-cylinder compound locomotives, those with a single low-pressure cylinder, have hitherto been able easily to generate a sufficient pull on the fire for the effective combustion of coal when at work, although exhausting from one cylinder only.

JOHN RIEKIE.

November 8th.

THE SPRINGING OF LOCOMOTIVES.

SIR,—In your issue of the 4th inst. (page 510), Mr. P. Sedgfield refers to the advantages of using compensating levers in order to counteract the disturbing effect of possible inequalities in the track. In a general sense, these levers are not employed to any great extent in British practice, except on the Great Western Railway. On that line they are fitted to the springs of the driving and coupled wheels of the 4–6–0's and 2–8–0's. In the latter tender type the eight-coupled wheels are compensated in two groups, and the pony truck has an equalising beam connected to the springs of the leading pair of coupled wheels. The pony trucks of the 2–6–0's (both inside cylinder and outside cylinder classes) are similarly arranged, as are also those of the 2–6–2 and 2–8–0 tank engines, but the coupled wheels themselves are non-compensated. Thirty of the 2–6–2's have inside cylinders, and have a "compensated" pony truck at each end. The 4–4–2 tank engines, and the 2–6–2's with outside cylinders, have trailing radial axles, and the springs of these axles are equalised with the springs of the rear coupled wheels, a plan which is, I think, somewhat unusual, but which would seem to have a good deal to recommend it.

F. W. BREWER.

Stevenage, Herts., November 9th.

THE SUKKUR BARRAGE.

SIR,—My attention has been drawn to a letter in your correspondence columns of October 7th last, wherein Mr. E. S. Bellasis disputed opinions on the Sukkur Barrage irrigation project which were expressed by me in an article that appeared in THE ENGINEER on December 24th, 1926.

I shall be pleased at any time to deal with any statements which he may support with facts or figures that can be definitely grasped and verified or refuted ; but it would be futile to pursue speculative generalities that lead nowhere definitely.

In the article above-mentioned I quoted the well-established formula for reckoning discharge, under afflux, over a "drowned" weir, viz.,

$$Q = \tfrac{2}{3} c_1 \sqrt{2g} \left\{ (H + Ha)^{\frac{3}{2}} - Ha^{\frac{3}{2}} \right\} + c_2 x \sqrt{2g} (H + Ha)^{\frac{1}{2}}$$

wherein H represents the afflux, Ha the head due to velocity of approach, x the depth of weir crest below tail water, and c_1 and c_2 are coefficients of discharge through the "free" and "drowned" portions respectively of the waterway over crest. I mentioned that 0·577 and 0·80 were the values usually assigned in India to c_1 and c_2, and showed that if, in the case of the Sukkur Barrage, those values were assigned to these coefficients and that if the mean velocity of approach were assumed to be 10ft. per second, so as to make Ha = 1·5ft., the afflux necessary to discharge the maximum flood of 1,500,000 cusecs would be 4ft. I also showed that if, as an extreme supposition, the velocity of approach was put at 12ft. per second, with $c_2 = 0{\cdot}90$, the calculated afflux would still be not less than 2·25ft.

Mr. Bellasis declares that the velocity of approach would actually be 13·2. If he will state his authority for this figure, or show by what process he has arrived at it, I will demonstrate that it is wrong. But let him make sure, first, that he has not confused the barrage site with the outfall station, 6100ft. upstream of it.

He also asserts that the coefficients of discharge have been wrongly valued by me. Let him state, then, what values he would assign to c_1 and c_2 respectively, and I will then deal definitely with his figures.

Mr. Bellasis relies on an American method of reckoning afflux that originated ten years after his retirement from active service, and which therefore he has never had opportunity to test practically. By this process he reckons that the afflux will be 1·34ft.; but if he were to set forth the process of calculation it could easily be shown to be dependent upon debatable assumptions. Conscious of this sort of consideration, the average prudent engineer is careful to design with a margin of safety, to guard against error. It was an eminent mathematician who wrote : "The mathematical method, as applied to physics, must always be trustworthy, or untrustworthy, according to the data employed ; the most complete presentation of symbols or processes will only serve to enlarge the consequences of error hidden in the premises, if such there be."

The Sukkur project engineers calculate that the maximum afflux at the barrage will be less than 1ft.; that the back-water effect of this will diminish at the outfall station, 6100ft. upstream, to 4in. or 5in. only ; and that it will vanish altogether before reaching the Bhakkar gorge, 3 miles upstream of the barrage, and so will not affect conditions of flow there.

Mr. Bellasis, on a previous occasion, said that the project engineers were quite correct as regards the afflux at the barrage, and at Bhakkar ; though he reckoned that at the outfall station the back-water rise would be 0·88ft. But now he calculates that the afflux will be 1·34ft. at the barrage and 0·75ft. at Bhakkar gorge. That is to say, he reckons that the afflux at Bhakkar will be nearly the same as the project engineers reckon it will be at the barrage !

In my article of December 26th, 1926, I tabulated figures and a diagram showing that the water surface of the Indus, when in flood, rises, instead of falling, downstreamwards in the 1800ft. length between Din Belo and Gao Ghat, and I described this as a "standing-wave formation." Mr. Bellasis declares that a standing wave cannot occur unless V^2 be greater than $g\,d$, and that this is "wholly impossible in the gorge." But Din Belo is at the exit of the "gorge" proper, and it is evident from what he has written that he has no experimental first-hand knowledge of the various phases of the standing wave phenomenon. Let him, in the first place, produce plans and sections of the river at Din Belo, proving that it is impossible for V^2 to exceed $g\,d$ there, and I will then add to his knowledge of the subject. Meanwhile he may ponder over the story about the old lady who refused to believe in the reality of an elephant the first time she saw one, because, she said, it was "physically impossible."

F. W. WOODS.

London, November 7th.

BESSEMER BASIC STEEL.

SIR,—I am afraid I cannot accept Mr. J. W. Hall's courteous suggestion in your issue of October 21st that the difference between us is one of degree only. I cannot even reconcile Mr. Hall's own statements. In his "Metallurgy of Steel," published in 1916, he stated :—

"An experienced blower, working with good metal, rarely has to take more than two samples besides the final one, and generally only one. He can detect by the fracture the difference between 0·06 and 0·07 per cent. of P in the steel, and very seldom makes a mistake in judging the per cent. of P present."

In his article in your issue of September 9th he told us :—

"Hence the blower is between the devil and the deep sea. The after-blow only lasts about three minutes, so that the workman must be extremely accurate—it is a question of only a few seconds—and unless the pig is exceedingly regular in composition, the workman's eye is very easily deceived, and there is practically no remedy for his mistake."

I cannot reconcile these two statements, and I see no explanation of the discrepancy, except that in 1916 Mr. Hall was writing in a scientific spirit, while in 1927 he is allowing a subconscious political prejudice to override his better judgment.

So far as I know, neither the German nor any other continental steelworks either add or "import phosphoric material to make up the difference." I have not said, and I do not agree, that the Bessemer basic process is necessarily unsuitable for making high carbon steels. But it is true, as Mr. Hall has indicated, that a percentage of P, completely innocuous in a soft steel, may become inadmissible in a high or medium carbon steel.

The reason, as I understand, that the British Engineering Standards Association has removed the Bessemer basic process from certain of its specifications for rails is simply that no Bessemer basic steel is made in this country ; in any case, its action affords no evidence one way or the other on the point at issue.

An article by Mr. C. J. Allen, in *The Railway Engineer* of January, 1922, gave some very interesting comparative details of three large lots of rails made of Bessemer basic, open-hearth basic, and Bessemer acid steel respectively. The Bessemer basic rails, containing 0·40 to 0·50 per cent. carbon, compared very favourably with the others. Indeed, the only cast which had to be rejected was a 50-ton cast of open-hearth steel.

What seems to have led Mr. Hall to think that we differ only in degree are my statements that the Bessemer basic "is essentially a mass production process," and that "in general, a better and more reliable steel is, in fact, produced in Great Britain than on the Continent." But I added that : "Mild steel of the highest quality can be, and at some works is made by the Bessemer basic process." Surely this only suggests a wise discrimination. It would seem that, to Mr. Hall, "mass production" suggests something cheap and nasty and generally abhorrent. To my mind, however, cheapness is a virtue and not a vice, and it is not necessarily associated with nastiness. Indeed, it is in mass production that I see the only possibility of our industrial salvation. I am further of opinion, though it sounds almost a paradox in the present state of public opinion, that a wise buyer will not necessarily use the most expensive materials available, but the least expensive that will serve his purpose, when due allowance is made for quality, durability, and so on.

R. A. SKELTON.

London, November 3rd.

FLETTNER RUDDERS.

SIR,—I see that Mr. F. A. Best has now written on this subject, and if you will kindly grant space for me to reply, I shall not seek further indulgence.

His calculation of 9·6 as the horse-power required to overcome the resistance of the Flettner fin (as distinct from that of the main rudder), when the helm is hard over, may seem small, but I think it very important to remember that the fin resistance—varying in amount as the helm is shifted—is continuously operative throughout the voyage, absorbing power not only while turning the main rudder, but also afterwards, in order to maintain it in the required position. In the case, however, of a plain spade rudder (in which part of its area is also forward of the stock axis) similarly hung, but turned by a steam, electric, hydraulic or other engine, the expenditure of power is intermittent, being only incurred while shifting the helm.

If the vessel referred to—viz., the Sorrento—were fitted with such a plain rudder, I should say it is a moot point as to whether, on a given voyage, the total number of horse-power hours actually provided by the steering engine would be greater or less than that provided by the propelling engines in overcoming the resistance of the fin, were she performing the same voyage but equipped with a Flettner rudder.

The percentage of saving in prime cost which Mr. Best mentions seems a rather debatable point, and possibly the plain plate rudder he refers to is that type in which the blade lies wholly abaft the stock, and whose framework is exposed—such a rudder, it will be seen, I have not had in view, *vis-à-vis* the Flettner. I see no reason why a plain spade rudder (generally similar in shape to the main part of the Flettner), with the adjacent part of the hull should be more costly than if a Flettner rudder were provided instead.

The relatively broad beam of the new Wallasey boats I should think not unfavourable to their rapid turning, as compared with narrower ships of the same length—a smooth saucer-like hull should spin round readily.

As regards docking to get at the submerged mechanism, I anticipated that trimming by the bow, or perhaps even careening, might sometimes be resorted to ; but as I thought that calm water would be necessary while doing so, I merely used the comprehensive term "docking."

V. J. MARTIN.

West Kirby, November 3rd.

SIXTY YEARS AGO.

IN our issue of November 8th, 1867, we recorded the death, on October 31st, of William Parsons, Earl of Rosse. He died at his house near Dublin at the age of sixty-seven. Lord Rosse, we wrote, loved science for its own sake and walked in its paths with a steadfastness of purpose seldom paralleled. He carried human research into the boundless regions of space with a firm hand and a fine sense of the value of eternal truth. He pursued the study of astronomical science with the greatest assiduity, and in particular taught mankind how to make large reflecting telescopes. His chief work was the construction of a magnificent 6ft. speculum telescope, in the making of which he "displayed engineering talents of the very highest order brought to perfection by cultivation." In 1849 he was elected President of the Royal Society, and subsequently had many honours conferred upon him by British and foreign academic and other bodies. We mourned his departure. That his place in the ranks of the great army of science would be speedily filled was more than we dared to hope. His fourth son, Charles Algernon, was then in his fourteenth year. He has lived to outshine his illustrious father. He has not only given the world the steam turbine but has continued his father's work in optics and particularly in the manufacture of mirrors. . . . In the same issue we reported that what we described as the first vessel ever driven by oil fuel was at the moment lying off Woolwich undergoing inspection by the engineering department of the dockyard. This vessel was the Minnie, a steam yacht owned by Mr. Arthur Barff. She was fitted with a petroleum fuel-burning apparatus of Mr. Barff's own invention, and had recently been equipped by Easton, Amos and Anderson, of Erith, with an improved boiler designed to develop the full advantages of liquid fuel. With her tanks full, we stated, she carried fuel for four times as long a run as when she was fired by coal. Her boiler (*sic*) was stated to be of 10 horse-power. It generated steam at 45 lb. Her speed was 9½ knots. The quantity of oil consumed was stated to be about 3 gallons per hour. The many advantages which mineral oil possessed as a fuel, we wrote, rendered the success attained in the little vessel very important. Contrasted with what is achieved with oil-fired marine boilers to-day, the claim made to success in the Minnie seems fantastic. Assuming that her engines were of 10 horse-power the consumption recorded works out at about 2·8 lb. of fuel per horse-power hour. To-day in large oil-fired liners we have got down to between 0·6 lb. and 0·7 lb. per shaft horse-power for all purposes.

THE Government of New Zealand has approved the proposals of the Fuel Research Committee to organise a laboratory and staff with the object of completing a survey of New Zealand coal and investigating improved processes for the utilisation of coal, the cost to be shared by the coalowners and the Government.

Railway Matters.

THE position of district engineer at Darlington, vacant by the retirement on June 30th last of Mr. J. C. Valentine, has been filled by the London and North-Eastern directors having appointed Mr. T. H. Bygate, chief assistant to the district engineer at Hull.

IN a fog which occurred on the evening of October 31st two opposing passenger trains, which should have crossed each other at Ware Station on the L. and N.E.R. Hertford single-line branch, met in head-on collision. Both engines were badly damaged and one of the firemen was seriously hurt.

THE application of the Trafford Park Company that it should receive the standard charges authorised by the Railways Act, 1921, has been refused by the Railway Rates Tribunal on the ground that Trafford Park railways were made under a Light Railways Order, and thus the Act does not apply.

THE forthcoming retirement of Sir Guy Granet from the chairmanship of the London, Midland and Scottish Railway was mentioned in this column in our issue of August 5th. Sir Guy's retirement is now complete, and he has been succeeded by Sir Josiah Stamp, who was made a director in July last, and who will continue to be the president of the Executive.

THE successor of Mr. R. C. Irwin as secretary to the London, Midland and Scottish Railway is Mr. F. G. Evans, at present the chief stores superintendent. It has, however, been in accountancy that Mr. Evans has earned his promotion to his new high office, as for years he held an important position in the audit accountant's office of the London and North-Western. The new chief stores superintendent is Mr. W. A. Ree.

THOUGH the fall in passenger traffic, as compared with 1925, continues there are still being recorded week by week gratifying increases in the goods receipts. The London and North-Eastern is now £1,011,000 to the good and the Great Western £530,000. The London, Midland and Scottish is down but only to the extent of £415,000. Naturally, as it relies mainly on the passenger traffic, the Southern is the worst off; it has a decrease of £214,000.

THE stations at Spa-road and Southwark Park, between London Bridge and New Cross on the eastern section of the Southern Railway, were closed to save labour during the war, and, being unremunerative, have not been reopened. The influence of that fact on the transit facilities in South-East London was considered by the London and Home Counties Advisory Committee on London Traffic, but no change was recommended. The stations are now being removed entirely, and as they have island platforms their removal will permit the main lines to be straightened.

THE paper by Mr. R. Bell on "Goods Traffic on British Railways," referred to in our Seven-day Journal of October 21st, has prompted a remarkable letter in *The Times* of the 27th idem from Mr. George C. Locket, the importance of which lies in the fact that the writer is one of the three members of the Railway Rates Tribunal. Mr. Locket says that he has just returned from the United States, whither he went for the express purpose of inquiring into the causes of the remarkable recovery of the American railroads since their practical collapse in 1920. He, in effect, maintains that that recovery is due mainly to the operation of shippers', i.e., traders', advisory boards. In *The Times* of the following day was a rejoinder from Mr. R. R. Dunwoody, in his capacity of secretary to the Association of British Chambers of Commerce, in which he said that twenty-eight of the local Conferences advocated by Mr. Locket were in existence. He pleads, however, that under the Railways Act, Section 28, they should legally be made part of the machinery in the relations between railways and the traders.

THE colour light system of signalling, whereby semaphore arms are dispensed with, since the signals, by day as well as by night, are given by lights, was installed by the Southern Railway, in connection with its electrification, at Holborn, Blackfriars, Charing Cross, Cannon-street, and up to the western end of London Bridge Station. It has been so successful, especially as giving better signal indications in foggy weather, that it is now to be extended from Borough Market Junction, through London Bridge to Spa-road. The central, or former Brighton, section from the terminus at London Bridge to Bricklayers' Arms Junction and Old Kent-road, is to be similarly treated. In addition to the provision of light signals, there is to be a new signal-box at London Bridge, which will contain a Westinghouse all-electric frame of 311 levers, to do the work of all the existing boxes in and outside both stations at London Bridge. Whilst great credit is due to the Southern Railway for this appreciation of light signals, the earlier success on the Liverpool Overhead and the Great Central also, and most particularly on the Metropolitan, must not be forgotten

LAST Sunday, November 6th, was the twentieth anniversary of the agreement between the railway companies on the one hand and the trades unions on the other with the Board of Trade for the establishment of a conciliation scheme. For over twelve months there had been considerable unrest among the men, which led to their approval at a mass meeting in Birmingham in November, 1906, of a national programme. That was submitted to each of the companies by Mr. Richard Bell, the then secretary of the Amalgamated Society of Railway Servants, but they all either ignored it or declined to meet a deputation of the men should they be accompanied, as was proposed, by Mr. Bell. By the autumn of 1907 matters had reached such a pitch that a ballot was taken on a strike to enforce the programme, including the principle of recognition; 76,925 voted to strike and 8773 against. Mr. Lloyd George, who was the President of the Board of Trade, then took the matter in hand, and, acting as mediator, secured an agreement. After the general railway strike of August, 1911, the Royal Commission which had to inquire into the working of the conciliation scheme, said of it in their report: "Bearing in mind the circumstances of the situation, the agreement, as an entirely new departure, cannot be regarded otherwise than as a promising solution of a question pregnant with difficulties."

Notes and Memoranda.

A STORAGE reservoir for the crude oil from the local wells at Taft, California, has been formed by building an earth dam 64ft. high in a valley in the hills.

ACCORDING to *Canada* a dog train, of five dogs, hauling a sledge over snow, can transport 2 tons a distance of 200 miles at a cost of 1500 dollars. Their average speed is about 5¼ miles per hour. The Hudson's Bay Company estimates the cost of dog haulage at 3·35 dollars per ton-mile, and a day's journey to be 20 miles.

IN the past twenty years the estimated value of the annual mineral production of Canada has increased by nearly 300 per cent., and now reaches the impressive figure of close on fifty million pounds. The peak of production is still a long way off and can merely be guessed at while vast areas of potential mineral interest in the North remain unexplored and unprospected.

THE barium-carbonate method for the treatment of boiler feed water rich in magnesium chloride is being experimented with on the Australian Trans-Continental Railway. From an account of the subject in *The Times Trade Supplement*, we gather that very encouraging results are being obtained. The cost of treatment amounts to 4s. 6d. per 1000 gallons, but this is not considered excessive in view of the very serious difficulties which the highly mineralised bore waters were causing to Australian locomotive boilers.

IN commenting on the explosion of a small locomotive type boiler, the Board of Trade Engineer Surveyor-in-Chief, says: "Had this boiler been inspected by a competent person, the defect would have been apparent and proper measures could have been taken to put the boiler in a safe condition. There appear to be still many boiler owners who do not realise their responsibility when working such appliances, and the serious consequences that may occur to other people in case of failure of any parts of the boiler through their neglect."

THE movement of a mountain, Monte Arbino, 5560ft. in height, is, says *Nature*, giving rise to such anxiety in the neighbourhood of Bellinzona, 3 miles to the east of which it is situated and not very far from the northern end of Lake Maggiore, that the authorities have ordered the evacuation of the zone of danger. The mountain has been moving horizontally since 1888 at an increasing rate per year, until during last year, 1926 alone, it had moved a foot. It has simultaneously lowered in height to a little more than the same extent, 14in. in 1926. The moving mass covers 2520 square yards. The Survey experts believe that the mountain will before long crash down into the valley of Arbedo, and that nothing can be done to avert the fall.

IN an article on the "Causes and Effects of Mining Subsidence," in *Nature*, Sir Richard Redmayne says that the universal adoption in Great Britain of the filling of the mine wastes with *débris* under hydraulic pressure—a system so largely practised in the Pas de Calais, the Westphalian, and some other continental coalfields—is impracticable, chiefly because of the cost, a conclusion which was also arrived at a few years ago, for a similar reason, by the Government Committee on Spontaneous Combustion in Mines. There are a very few exceptions, such as South Staffordshire, where the circumstances in respect of the presence of the necessary material and underground conditions are more favourable to its introduction. At Motherwell, in Scotland, where it is being advantageously employed the cost is estimated at 1s. 3d. per ton of coal raised.

THE well-known technical method of heating by bombardment with cathode rays has, according to *Nature*, been applied quantitatively by H. Klinkhardt to the measurement of specific heats. A specimen of the substance to be investigated is supported on quartz in an evacuated enclosure, and brought to any desired temperature between 100 deg. and 1000 deg. Cent. in an electric oven. It is then made the anode for an electron discharge at a few hundred volts from an oxide coated filament and its subsequent change in temperature is followed by means of an embedded thermo-junction. The rate of supply of energy is known from the current and voltage, due allowance being made for contact differences of potential, and after applying the usual calorimetric corrections, the final results are claimed to be correct to within 2 per cent.

IN reporting on the failure of a traction engine boiler through the fusible plug blowing out, the Board of Trade Surveyor says that when the boiler was examined the threads on the plug were found to be in a very defective condition, indicating that a leakage had been taking place there for some time, and had worn away the plate in the vicinity of the hole until it was at this part reduced to ⅛in. in thickness, leaving practically no hold for the threads to keep the plug in its place. The water gauge was examined, and whilst not being fully choked, it was found to contain a sediment of soft deposit in the passage to the water end which would make it sluggish in its action. The fire-box crown plate was examined, and did not show signs of overheating on the fire side, but the scale around the plug, which, from appearances, was all that was holding it in position, had cracked away, possibly due to slight overheating.

A RATHER unusual form of accident to a Lancashire boiler is described in a recent official report. A leaky rivet was discovered, so the boiler was kept under observation, and at an inspection about 2 p.m. the manager warned the fitter not to attempt to stop the leak, and not to touch the rivet in any manner, as the boiler was due to be laid off for cleaning in a few days. At about 4.45 p.m., in direct opposition to instructions, the fitter decided to make an attempt to stop the leak. He ascended a ladder placed in front of the boiler, and with a caulking tool and hand hammer commenced to caulk the edge of the rivet. With several light blows he stopped the leakage at one part, and was about to continue on another part when the rivet blew out with a loud report followed by a rush of steam. At the first sign of rupture he threw himself backwards from the ladder and very fortunately escaped with slight scalds on the face and hand, and a few bruises. The steam pressure on the boiler at the time was about 140 lb. per square inch.

Miscellanea.

IT is intended to improve the coal bunkering and loading facilities at the port of Hartlepool.

IT is proposed to expend nearly £125,000 on the extension of the electricity plant at East London, South Africa.

A TRIAL cargo of iron ore was recently dispatched from the port of Rabat, in Morocco, for Middlesbrough. The ore was from the newly-opened mine at Tiflot.

THE Junction Mine, at Broken Hill, Australia, of the Sulphide Corporation has, it is reported, been closed down on account of the exhaustion of the ore reserves.

IT is proposed to put up new blast-furnaces at the Anzan Steel Works of the South Manchurian Railway Company, with the idea of increasing capacity from 200,000 tons to 500,000 tons a year.

A NEW headstead is to be erected at Boldon Colliery, Durham, with all the latest improvements. It is expected that after it gets into full working order the colliery will draw about 4000 tons a day.

IT is proposed to build a railway bridge at Chicopee Falls, Massachusetts, by means of the arc welding process, without any riveted joints. It is estimated that it will require only 80 tons of material, as compared with 120 tons by orthodox processes.

A NEW zinc refining plant is about to be put in operation at West Kootenaw, British Columbia, with a power consumption of some 100,000 horse-power. It is proposed to utilise a further 150,000 horse-power on the Pen d'Oreille, near Cascade, for the same purpose.

CONSTRUCTION of aeroplanes is proceeding at such a rate at the aircraft factory of Canadian Vickers, Ltd., that it is proposed to extend the present plant by the erection of another building. It was only last autumn that a new shop was added, and this is now being transformed into a two-storey structure.

THE coal distillation plant which is to be put up at Inverness, Nova Scotia, is to have a capacity of 1600 tons of coal a day. It is expected to produce 16,000 gallons of volatile by-products a day and to have sufficient surplus gas for the generation of a considerable amount of electric power. The works will employ 3000 hands.

IT is claimed that the fibre-board plant, which is to be put up at Gatineau, Quebec, by International Fibre Board, Ltd., will be the largest of its kind in the British Empire. The output is to be 100 tons, or 250,000 square feet of board, a day, and 15 tons of wood flour. The power consumption will be from 5000 to 6000 horse-power.

ACCORDING to the *Iron and Coal Trades Review*, the French Nitrogen Company L'Azote Français has formed a subsidiary company, with a share capital of 12,000,000f., for carrying on a process making use of tidal power under a patent which has been tested by the Commission of Blue Coal (Tidal Power Commission) attached to the French Ministry for Public Works.

THE British Consul-General at Cologne reports that, according to the *Deutsche Bergwerks Zeitung*, a recent decision of the Solingen Steelware Manufacturers' Association compels members to add an additional charge, which, including the advance in July, will amount to a total increase of 10 per cent. This is due to the fact that wages, which were raised 5 per cent. in the spring, have been further increased this month by 8 to 10 per cent.

A SHORT-WAVE wireless station has been built at Hsihwayuan, Nanking, capital of Kiangsu Province, China. This new station can communicate with Loyang, Canton, Shanghai, Ningpo, Amoy, Tungshatao, and the Philippines. Only Government and military messages are sent and received at present. This and the short-wave stations in Shanghai, Loyang, Canton and Ningpo were built with machinery produced by the factory in Shanghai established by Li Fan-yi, Chief of the Department of Communications of the Revolutionary Army's headquarters.

THE British Commercial Secretary at Cairo reports that total imports of bicycles into Egypt during 1926 amounted to 3026, valued at £E12,018, as compared with 2061 valued at £E9294 in 1925. During last year French competition increased appreciably, with the result that that country again headed the list of suppliers to the Egyptian market with an import of 2017 valued at £E7423, as compared with 981 worth £E4364 in 1925. Imports from the United Kingdom in 1926 were only 580 worth £E2534. A glance at these values will, however, show how low were the prices asked by French firms. Italy contributed 224 valued at £E1296, but only 84 came from Germany.

THE production of coal in France during September showed that, despite the efforts to bring more prosperity to the coal mining industry, the decline has continued, the output in that month being 168,914 tons, as compared with 195,000 tons in March last, when the collieries appeared to have reached their maximum production. It was hoped that the attempt to restrict the importation of coal by means of licences and by offering specially low freights on French coal would have enabled coalowners to dispose of the whole of their fuel, but they cannot compete with foreign prices, and it is now recognised that, so long as the consumption is limited by the industrial depression, the only hope for the home industry lies in reducing wages and working more hours.

THE Bombay Engineering Congress began its thirteenth annual session on November 7th, and was attended by over one hundred engineers from all parts of the Presidency. The Commissioner in Sind opened the proceedings with a brief speech cordially welcoming the members of the Congress to Karachi. He reminded them that although the Congress was founded in 1914, the present was its first session in Karachi, and he sincerely hoped it would not be the last. Mr. Measham Lee, chief engineer of the Karachi Municipality and President of the Congress, then delivered an address in which he discussed the development of Karachi and the difficult engineering problems which had to be tackled. He referred to the vast irrigation schemes in the Punjab and Upper Sind that were designed to irrigate millions of acres of land which, he said, would treble Karachi's export trade within the next few years.

THE FERRYBRIDGE STATION OF THE YORKSHIRE ELECTRIC POWER COMPANY

MR. W. B. WOODHOUSE, M.I.E.E., LEEDS, ENGINEER

(*For description see page* 532)

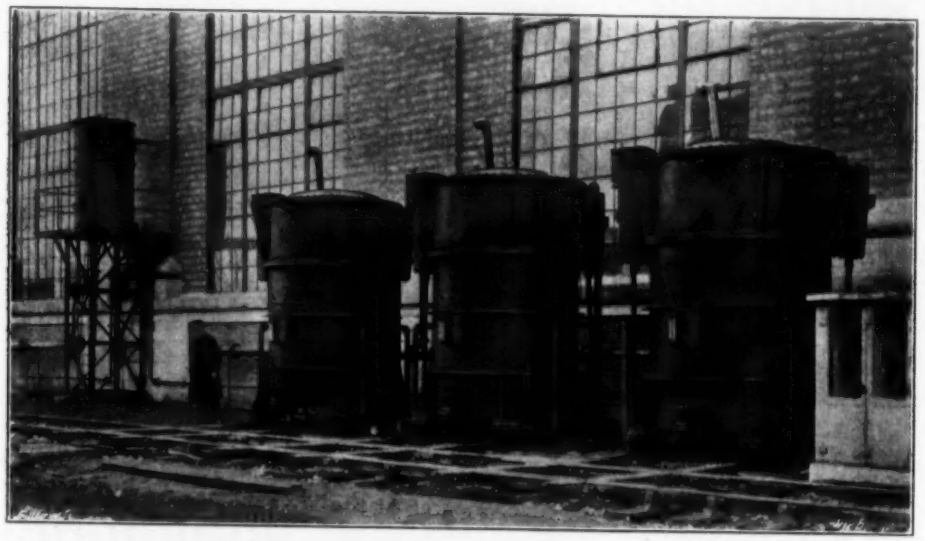


FIG. 17—GROUP OF THREE 8333·3 K.V.A. FERRANTI TRANSFORMERS

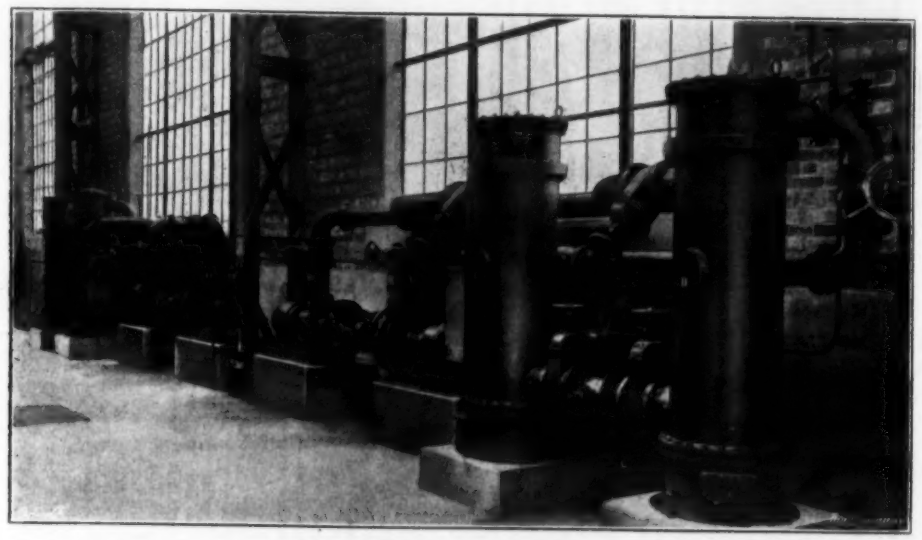


FIG. 18—TRANSFORMER OIL COOLING PLANTS

FIG. 19—B.T.H. SOLENOID PILLARS AND SIGNAL LEVER HANDLES IN SWITCH HOUSE

FIG. 20—B.T.H. BENCH-PATTERN CONTROL BOARD

The Engineer

Annual Subscription Rates

(including postal charges).

Subscriptions will be accepted by the Publisher direct or through a newsagent at the rates and in the currencies stated below:

BRITISH ISLES	£3 5 0	
CANADA	£3 3 0	Thick Paper edition.
	£2 18 6	Thin Paper edition.
ABROAD (except Canada)	£3 7 6	Thick Paper edition.
	£3 3 0	Thin Paper edition.

AFRICA	Central News Agency. All Branches
* £3 7s. 6d.	CAPE TOWN: Wm. Dawson and Sons, Ltd.,
† £3 3s. 0d.	29–31, Long-street (Box 489)
	JOHANNESBURG: C. Juta and Co.
ARGENTINA	BUENOS AIRES: Mitchell's Book Store, 576,
* £3 7s. 6d.	Cangallo
† £3 3s. 0d.	
AUSTRALIA	Gordon and Gotch (Australasia), Ltd. All
* £3 7s. 6d.	Branches
† £3 3s. 0d.	MELBOURNE: Robertson and Mullens, Elizabeth-street
BELGIUM	BRUXELLES: W. H. Smith and Son, 78–80,
* Fr. 590	Rue du Marché-aux-Herbes
† Fr. 550	
CANADA	American News Company, Ltd. All Branches
* $15·25	MONTREAL: Gordon and Gotch, Ltd., 334,
† $14·25	Notre Dame-street, W.
	TORONTO: Wm. Dawson and Sons, Ltd., 87, Queen-street East
	TORONTO: Gordon and Gotch, Ltd., 45, Richmond-street, E.
CEYLON	COLOMBO: Wijayartna and Co.
* Rs. 44·5	
† Rs. 41·5	
CHINA	HONG KONG: Kelly and Walsh, Ltd.
* $33	SHANGHAI: Kelly and Walsh, Ltd.
† 831	
EGYPT	CAIRO: Express Book and Stationery Store,
* £3 7s. 6d. (Pt. 330)	9, Chareh Maghrabi
† £3 3s. 0d. (Pt. 308)	
FINLAND	HELSINGFORS: Akademiska Bokhandeln,
* M. 630	Alexandersgatan, 7
† M. 605	
FRANCE	PARIS: Boyveau and Chevillet, Rue de la
* Fr. 418	Banque, 22
† Fr. 390	PARIS: Berger Loverault, 229, Bld. St. Germain
	PARIS: Brentano's, 37, Av. de l'Opera
	PARIS: Dunod, 92, Rue Bonaparte
GERMANY	BERLIN: H. Hermanns, Friedrichstrasse 218, S.W. 48
* R. mks. 70·00	WESTERN GERMANY: Fritz Rehfus, Blumen-
† R. mks. 65·00	thalstrasse 10, Cologne
	LEIPZIG: K. W. Hiersemann, Konigstrasse 29
HOLLAND	ROTTERDAM: Hector's Boekhandel, Noord-
* Fl. 41·00	blaak 59
† Fl. 38·00	ROTTERDAM: Techn. Boekhandel, "Plan C," Gelderschestraat 4
INDIA	BOMBAY: Thacker and Co., Ltd.
* Rs. 45	CALCUTTA: Thacker, Spink and Co.
† Rs. 42	
ITALY	MILAN: Ulrico Hoepli
* Lire 298	ROME: Maglioni and Strini, 307, Corso
† Lire 278	ROME: Fratelli Treves, Corso Umberto 1, 174
	ROME: Fratelli Bocca
JAPAN	Maruzen Co., all Branches
* £3 7s. 6d.	
† £3 3s. 0d.	
JAMAICA	KINGSTON: Educational Supply Co.
* £3 7s. 6d.	
† £3 3s. 0d.	
NEW ZEALAND	AUCKLAND: Whitcombe and Tombs, Ltd.
* £3 7s. 6d.	Gordon and Gotch, Ltd. All Branches
† £3 3s. 0d.	NAPIER: J. Wilson Craig and Co.
RUSSIA	LENINGRAD: Mezhdunarodnaya Kniga, Pros-
* £3 7s. 6d.	pect Volodarsky, 53 A
† £3 3s. 0d.	MOSCOW: "Litisdat," Kousnetsky Most, 5–15
STRAITS SETTLEMENTS	SINGAPORE: Kelly and Walsh
* $29·00	Ltd.
† $27·00	
SWEDEN	STOCKHOLM: A/B Wennergrens Journal-
* Kr. 61·00	expedition, Stockholm 1
† Kr. 57·00	STOCKHOLM: A/B C. E. Fritzes Kungl., Hofbokhandel, Fredsgatan, 2
SWITZERLAND	BERNE: Joh. William De Groot, Laupenstr. 5,
* Fr. 86·00	ZURICH: Rosa Leibowicz, 4, Ankerstr.
† Fr. 80·00	
UNITED STATES OF AMERICA	International News Co. All Branches
* $16·25	
† $15·25	

* *Thick Paper.* † *Thin Paper.*

These rates are liable to alteration if exchange fluctuations require it.

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication).

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. Central 2256, 2257.

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which likely to be of interest to engineers.*

Contents.

THE ENGINEER, November 11th, 1927. PAGE

A SEVEN-DAY JOURNAL .. 527
AN AMERICAN DIARY. No. XVI. .. 528
RIVER ROTHER IMPROVEMENT WORKS. (Illus.) .. 529
IN CANADA WITH THE EMPIRE MINING CONGRESS .. 530
THE FERRYBRIDGE STATION OF THE YORKSHIRE ELECTRIC POWER COMPANY. No. III. (Illus.) .. 532
X-RAYS AND THE CRYSTALLINE STRUCTURE OF MATERIALS .. 534
A NEW SIX-CYLINDER MOTOR OMNIBUS. (Illus.) .. 535
LETTERS TO THE EDITOR—
- British Locomotive Design .. 537
- Recent British Locomotives .. 537
- The Springing of Locomotives .. 538
- The Sukkur Barrage .. 538
- Bessemer Basic Steel .. 538
- Flettner Rudders .. 538

SIXTY YEARS AGO .. 538
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA .. 539
LEADING ARTICLES—
- The Man and the Job .. 541
- The X-Ray Analysis of Materials .. 541

LITERATURE .. 542
SHORT NOTICES .. 543
BOOKS RECEIVED .. 543
POWER-HOUSE EXTENSIONS AT STOKE-ON-TRENT. (Illus.) .. 544
THE MOTOR PASSENGER AND CARGO VESSEL ITAPE. (Illus.) .. 545
A BOILER EXPLOSION .. 546
CONFERENCE OF CZECH ENGINEERS .. 547
A ROTARY SIGHT FEED LUBRICATOR. (Illus.) .. 547
BOOKS OF REFERENCE .. 547
INSTITUTE OF FUEL .. 547
CONSTANT-RADIUS LUFFING CRANE. (Illus.) .. 548
A WAVE POWER MACHINE. (Illus.) .. 549
PROVINCIAL LETTERS—
- The Midlands and Staffordshire .. 549
- Lancashire .. 549
- Sheffield .. 550
- North of England .. 550
- Scotland .. 551
- Wales and Adjoining Counties .. 551

CONTRACTS .. 551
CURRENT PRICES FOR METALS AND FUELS .. 552
FRENCH ENGINEERING NOTES .. 553
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 553
FORTHCOMING ENGAGEMENTS .. 554
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 554
PARAGRAPHS—Royal Institution, 551—Prize Competition for the Best Paper on Goodwill in Industry, 551—The Institute of Indexing, 551—Engineering Salesmanship, 551—Swindon Excursions, 554

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscript: correspondents are therefore requested to keep copies.*

THE ENGINEER.

NOVEMBER 11, 1927.

The Man and the Job.

IN the chapter of "An American Diary" which we publish to-day the author gives his impression, derived from many conversations, of the direction in which the education of engineers appears to be moving in the United States at the present time. He refers once more to the scheme which Professor Fernald has just put into operation at the University of Pennsylvania, and remarks that, on the whole, America seems to be leaning towards methods of broadening the engineering intellect. None of the other engineering schools have, it is true, gone as far as that at Pennsylvania, which has reduced the period of specialised education to two years, but they are watching Professor Fernald's scheme with sympathetic interest, and it is safe to assume that if it justifies the anticipation of its founder it will be imitated in a greater or less degree in every engineering college in the United States.

The only test of the merits of any system of education is the fitness of the students for the vocation which they decide to follow. That simple truth has, we venture to say, been lost sight of. We have replaced "vocation" by "examination" and the acquisition of degrees has become the primary object of education. That is all wrong. If there were good and sound reasons for believing that degree examinations were a trustworthy index of the fitness of those who passed them for their vocations, then they might be accepted without demur in lack of a more rational test. But there are no such reasons. The degree examination is a purely educational test. It has to be made stiffer and stiffer—either by raising the standard of the questions or by increasing the percentage of marks necessary for a pass—year by year, in order to prevent degrees becoming as common as dead leaves in autumn. Now it is common knowledge that only a very small proportion of engineers who have succeeded in their profession make any use of the higher branches of the education which they received in their youth. Indeed, it would be possible to find quite as many men holding positions of responsibility who were incapable of passing a stiff examination in their student days as men in similar positions who had enjoyed a distinguished college career. In short, success in college is no index of success in life. Quite other qualities than those which are derived from the educational course determine the fitness of a man for a high place in industry. In America the recognition of that perfectly obvious fact has already had some effect upon the curricula of colleges, and is likely to have even more effect in the near future. Evidence seems to indicate that the standard of engineering education is not so high generally in the United States as in Great Britain, but it by no means follows that for the making of engineers it is not at least as good and, possibly, even better. The practice of engineering—let us be perfectly frank with ourselves—does not call for a highly scientific education. The number of engineers who make use of the higher mathematics amounts to no more than a trifling percentage of the whole, and amongst that small percentage there are but few who hold high positions in the industry. For ordinary every-day engineering the simpler rules of arithmetic and algebra supply the engineer's needs. But what the working engineer—not the professor—does want is an unassailable foundation of knowledge. He must be quite sure of certain elementary facts, and he must be able to express them in a simple mathematical form which will not hide their true meaning. Moreover, he should have a wide general knowledge, not necessarily a quantitative knowledge, of a great number of physical laws, and if he intends to become a mechanical engineer he should saturate his mind with arrangements of mechanism. In days gone by the science student had Deschanel's "Natural Philosophy," or Ganot's "Physics" at his elbow all day long, and he sought recreation by poring over volumes of "Mechanical Devices." By the study of such books he filled his mind with facts about the primary laws of nature and made himself familiar with a great variety of mechanical arrangements. We believe such books have been replaced in these days by others more convenient when an examination is in prospect, yet in themselves less liberal than the old. To sum up, the science education which an engineer makes use of in his profession is, in fact, a very simple one, but it is important that in the elements it should be very thorough and that it should be sufficiently extensive to stimulate the imagination.

Imagination is one of the most fruitful possessions of the engineer; it is the progenitor of invention itself, and the property which enables us to appreciate the inventions of others. It has been held that it is a natural gift and that it cannot be imparted by education. That may be in some measure true, yet certain it is that a liberal education does tend to encourage the imagination, whilst a narrow and specialised one, particularly when the passing of an examination is the ulterior object, tends to restrain it. We have only to look back upon the number of notable inventions made by men with no scientific, and often very little technical knowledge, to see that invention may spring from other sources than those which schools of engineering provide. Finally, it may be said of the liberal, or broad, education that it does make men more fitted to take a place in the world than a narrow one. The importance of that side of engineering increases year by year as a larger and larger proportion of engineers are expected to be men of affairs, and it is probably the appreciation of that fact, coupled with the admission, based on experience, that the higher knowledge is required in their vocation by but a small proportion of engineers, that is leading American educationists to fit men for their jobs by enlarging their minds and sympathies through the medium of a broader training, and by making greater efforts to consolidate the simple foundations upon which engineering is built.

The X-ray Analysis of Materials.

THAT there is a limit beyond which the microscope ceases, and must of necessity cease, to be available for the examination of minute structures is a physical fact, the reason for which is probably not obvious to all whom it ought to concern. Yet the explanation is, as Sir William Bragg showed in his remarkably interesting Thomas Hawksley Lecture on Friday of last week, capable of being put in simple and convincing terms. Of the gamut of the waves in the ether so far detected, visible light covers just about one octave. There are at least twenty octaves above it and some forty or more below it. Towards the base end of the scale come the waves used in wireless telegraphy, with

wave lengths of one metre upwards. In the visible spectrum we encounter at the red end wave lengths of something over 1½ million to the metre and at the violet end wave lengths of about 2½ million to the metre. At the treble end of the scale we have the X-rays with wave lengths of from 800 million to 10,000 million to the metre, and beyond at the extreme end we find the γ rays emitted by radio-active substances which may run to a 1,000,000 million to the metre. Just as we cannot catch sand on a coarse riddle, so we cannot see particles of matter if they are smaller than the wave length of the light falling on them. It is for this reason that the shorter wave length light towards the violet end of the visible spectrum is employed by the microscopist to reveal particularly fine structures and conversely why the longer red waves from neon lamps are found useful at aerodromes for penetrating fogs. The limitation of the usefulness of the microscope is set by the limiting wave length of the visible spectrum. This fact being properly understood, it becomes easy to follow Sir William Bragg and his fellow-workers some way into the entrancing new field of study opened up by the application of X-rays to the investigation of the crystalline structure of materials. The wave lengths of the X-ray band are of the same order of magnitude as the atoms and molecules composing matter. By their means, therefore, it ought to be, and is, possible to obtain effects determined one way or another by the atomic or molecular structure of the material on which they are directed.

So far the subject is simple and the argument logical. Applied to the study of the structure of matter, X-rays give definite effects which are characteristic of the matter under investigation. When, however, we seek to interpret the meaning of these effects we arrive on ground which, as Sir William showed, is, for the present at any rate, both doubtful and debatable. The rays reflected from the material are caught and recorded on a photographic plate, and it is from the visible image developed on the plate that deductions have to be made regarding the structure of the matter examined. The matter can be presented to the X-rays in several ways. It may be reduced to a powder; that is to say, to a series of minute crystals oriented in all directions. The rays reflected from such a powder produce on the photographic plate a ring-like image or a series of concentric rings. They are reflected only from those crystalline particles which are oriented at a particular angle to the incident X-ray pencil. If therefore the particles are sufficiently numerous, some will be lying at the required angle to build up the ring-like image, while all the others will have no effect on the reflection. Again, a complete crystal may be set at random in the path of an X-ray pencil and caused to rotate about an axis perpendicular to the pencil. Chance may lead to the initial random setting giving a reflection, but in any event as the crystal is revolved the inclination of the rays to its various planes will change continuously and reflections will shoot out from the crystal as each set of planes assumes the characteristic reflecting angle relatively to the pencil. The result recorded on the photographic plate in this case is a collection of spots. These are two of several ways in which matter may be subjected to examination under X-rays. It is obvious that the interpretation of the visible record developed on the photographic plate demands close study, experience and skill. If it is sought to do no more than to use the method as a means of analysing the nature of the substance under examination, the work involved is relatively easy. Each element and each compound, however closely they may be related chemically, gives a different ring image, just as each element gives a characteristic flame spectrum. The method therefore presents a new and powerful adjunct to chemical analysis. It is, however, much more than a mere means of discriminating between different substances. The images developed on the photographic plates are, or are held to be, maps of the inner constitution of the matter examined, cipher maps the key to which has not yet been placed fully in our possession, but maps nevertheless which show us the relative disposition of the molecules, or molecular groups, from which the matter is built up. It should be noted that this new branch of scientific radiology is distinct in its aims and methods from the radiography developed and applied extensively during the war for the detection of hidden defects in materials, faulty workmanship and so forth. A radiograph is a shadow X-ray photograph, which shows the macroscopic structure of the object examined without revealing the microscopic or crystalline structure of the component materials. The subject to which Sir William Bragg and his fellow-workers have given their attention is properly to be described as X-ray crystallography. It reveals the atomic architecture of matter, and is only incidentally affected by the gross form in which the matter is presented to it for examination. The distinction is of importance. In radiography it is quite possible to compare the photographic record with the structure of the body examined and to establish with certainty that the photograph—or the transient image on the fluorescent screen—is a just picture of the hidden parts of the body. In X-ray crystallography, however, there is no such possibility of comparison. We do not know what the structure examined is, except from the indications developed on the plate and must therefore exercise imagination, controlled and cautious, in the interpretation of the signs revealed to us. In both branches the photographic plate plays the part of a detector of the rays, just as a coherer or crystal enables us to detect the existence of Hertzian waves. In radiography the possibility of comparing the image with the object enables the extent, if any, to which the detector is responsible for distortion to be determined. The distortion, as is well known to workers in this field, may, from a variety of causes, be considerable. In X-ray crystallography we must apparently take all known precautions against distortion and then assume that the developed image is a true product of the molecular structure of the matter examined, and is not contaminated by any effect arising from the molecular structure of the plate and its emulsion.

In his lecture last week Sir William Bragg gave the principal share of his attention to the application of X-rays to the study of the crystalline structure of metals. He was addressing an audience of engineers, and naturally chose for discussion the materials in which engineers are chiefly interested. It is not to be thought, however, that the new method of study is confined to metals. One of the most remarkable of the fundamental facts revealed by X-ray analysis up to the present is that many of the substances handled by man which are commonly regarded as being non-crystalline, really possess a crystalline structure and have their properties determined by that structure. Amorphous carbon, for example, has been found actually to consist of minute crystals of graphite. Even colloids, substances usually regarded as typically non-crystalline, have been shown in some cases to consist of minute, yet perfect, crystals, each of which contains only a few score of atoms. To all bodies possessing any regularity in their ultimate atomic structure, whether they be metals, oils or textile fibres, the new methods of X-ray analysis are applicable. The power of that analysis is therefore equalled only by the wide extent to which it may be applied. Already, special industrial applications for it are being devised and put into practice, as, for example, at the National Physical Laboratory. On that side of the account, however, it would be well to proceed with caution. Many workers are engaged on the purely scientific side of the subject, and although the progress being made is rapid and great, the position as yet is hardly sufficiently consolidated to justify the industrial or technical exploitation of the processes without constant and close touch with the purely scientific side, and the modified outlook which riper fundamental knowledge may and almost certainly will suggest.

Literature.

Brassey's Naval and Shipping Annual, 1928. Edited by Sir ALEX. RICHARDSON and ARCHIBALD HURD. London: Wm. Clowes and Sons, Ltd. 1927. 25s. net.

A COMPREHENSIVE record of naval and merchant shipping affairs in the past twelve months is furnished by the new volume of this old-established annual. As in previous editions, it is divided into two sections, dealing respectively with the world's fighting fleets and commercial shipping. Commander C. N. Robinson, the *doyen* of naval publicists, again contributes the opening chapter on the naval forces of the British Empire, with regard to which there have been notable developments since the last edition. This year has witnessed the completion of the first group of post-war vessels, including battleships and cruisers, and the holding of the Geneva Conference on naval limitation. The editors, it may be remarked, take a hopeful view of the transactions at Geneva, and do not anticipate any revival of competitive building as a result of the failure to reach agreement. The history of the Conference is reviewed very ably by Captain A. C. Dewar, R.N., who builds up a strong case against the American plea for limitation by total tonnage. He scores some telling points by quoting from America's own authorities. The naval outlook from the other side of the Atlantic is explained by Lieut.-Com. Tinker, U.S.N., who advocates closer co-operation between the two countries in preserving the peace at sea. He pays generous tribute to the sacrifices which the British Empire has made in the cause of armament restriction, but is, in our opinion, rather too severe a critic of Japan and her naval policy. Captain Paul Chack, of the French Navy, writes an illuminating chapter on his country's naval plans and problems. His analysis of the current building programme, and of the progress it has made to date, is particularly useful and timely. He lays stress on the difficulties confronting French designers and engineers when they were called upon to build cruisers and torpedo craft which differed fundamentally from all previous French types. The brilliant result of their labours was seen when Admiral Pirot's squadron visited Portsmouth last May. Admiral Sir Douglas Nicholson offers some pertinent criticism of present-day battleships and cruisers. He opposes the big-gun theory as exemplified in the "Nelson" class, condemns the torpedo equipment of these ships as superfluous, and sees no practical reason for their increased speed. As for cruisers, many officers share his view that our "County" ships are too large and expensive, though it is not easy to see how we can avoid building such vessels while they remain the standard type for other Powers. Decisive phases in the Battle of Jutland are elucidated by Admiral J. E. T. Harper, who exposes what he considers to be inaccuracies in Mr. Winston Churchill's version of the engagement. The possibilities of the flying boat as a means of both Empire defence and communication are examined by Major P. L. Holmes. He justly remarks that a marine type of aircraft particularly adapted to British requirements has been neglected in favour of land-going machines. It is not to be doubted that an adequate number of powerful flying boats would be of great value in assisting to patrol the trade routes in war time.

In reviewing the progress of the world's mercantile fleets the editors find the general position to have improved somewhat since last year. There has been a net increase in the volume of tonnage and a marked reduction in the number of laid-up ships. Marine engineering developments are recorded in another interesting chapter, which duly notes the stimulating effect of the rivalry between the steam engine and the Diesel motor. Although the latter is undoubtedly forging ahead, the steam engine has by no means reached the limit of improvement. Among other factors the introduction of high-pressure turbines may do much to prolong the era of steam. Some details of the trials of H.M.S. Nelson show this battleship to be very economical in steam consumption. Both in this chapter and in a later one, by Mr. A. Regnauld, electrical propulsion is brought under review. The subject is one of special interest at the moment, owing to the completion of the American aircraft carriers Saratoga and Lexington, each of these vessels having a turbo-electric plant capable of developing 180,000 shaft horse-power. Chapters on marine wireless progress and notable merchant ships of the year bring the mercantile section to a close. There are many illustrations of warships and merchantmen, including striking views of the Nelson and Adventure. The tabular material relating to both sections is, as usual, very complete and well-arranged. This volume, like each of its predecessors, will prove indispensable to all who desire to keep abreast of naval and shipping developments at home and abroad.

Text Books of Physical Chemistry; Ramsay and Dorman. Spectroscopy. By E. C. C. BALY, C.B.E., M.Sc., F.R.S. Third edition. Vol. III. London: Longmans, Green and Co., Ltd. Price 22s. 6d. net.

THIS volume is devoted entirely to the Bohr theory on the lime series in the spectra of the chemical elements, and its connection with previous fundamental work back to 1885, when Balmer published his empirical formula for the first nine lines of the hydrogen spectrum. The historical *résumé* is given with a fairness which one ought to be able to expect from a writer on pure science, but which one seldom meets in these modern days. It is a delightful story which the author tells of the work of Rydberg, who applied algebraical analysis in a simple form to a bewildering mass of wave lengths and their corresponding wave numbers and finally arrived at a simple expression for the wave numbers of various series of lines in the spectra of the elements, which expression contains one universal constant and another peculiar to each element. In its simplest form, Rydberg's equation is—

$$n = n_\circ - \frac{N}{(m + \mu)};$$

where n = wave number of any particular line,
$n_\circ$ = wave number at convergency limit,
N = Rydberg's constant,
μ = constant for element and series,
m = number: 3, 4, 5 . . . &c.

Methods for finding $n_\circ$ and μ are given and various modifications of the formula to suit different series, &c. The author points out the unexpected accuracy of

this expression, which was greater than that of the experimental results at the time—1890. Other work by Kayser and Runge and others on the application of algebraical analysis is also cited, and the reason for the greater usefulness of Rydberg's binomial, which is employed to this day for preliminary investigations. All this leads up to the Bohr theory of 1913.

Before leaving this introduction, the reviewer must point out that the author deserves the heartiest thanks from the older school of physicists for treating this astounding proof of the vitality of the simple, old-fashioned mathematical method of plotting curves of differences and finding the corresponding algebraical expressions apart from pre-conceived theoretical or perhaps hypothetical notions, in such a complete and sympathetic manner.

When he introduces Bohr's theory, the author emphasises that this investigator started with the intention of finding an explanation of the Rydberg and Ritz formulæ in the properties of the Rutherford atom. After a brief discussion of the orbit of the one electron of the hydrogen atom round the central nucleus and the *impasse* arrived at when applying the laws of classical electro-dynamics, he brings forth Planck's quantum theory as the saviour of the conception in view of the spectrum being composed of lines and thus discontinuous. Bohr proceeds by assuming the Rydberg formula for the hydrogen lines as being correct, and then finds an expression for the constant N in the values of the various quanta as known from Millikan's mensurations in conjunction with the velocity of light, using the total atomic energy W as a point in common between the two lines of reasoning. The value of N arrived at in this way agrees very closely with Rydberg's own figure. This demonstration—pages 63–65—is very condensed and creates the impression of being dictated largely by piety on the part of the author for giving credit to Rydberg's work as having influenced Bohr in his classical effort, which probably is not far from the truth. In the recent translation of Haas, "Atomic Theory" (Constable, 1927), another demonstration is given, which is more lucid, but makes Bohr act by a sort of divine inspiration, introducing values of the large axis of the electron orbits as varying by steps with the changes 1, 2, 3, and 4 elementary quanta, the angular velocities and the frequencies following as conclusions from this original *posito*. Haas makes Balmer's original work on hydrogen the basis of the application to spectrology, but ascribes Rydberg's binomial to him. The author under discussion lends an additional charm to his book by adhering to the historical sequences of the development of theoretical spectrology, and his present edition is up to a point readable to a fairly wide circle of those interested in the latest phases of the advance of science.

There has been no abrupt revolution in this field, the experimental material has grown vast enough for great generalisations, and Bohr's is one of the greatest. The lines of the spectrum are the safest support of the quantum theory, which, however, may any day give way to a theory of harmonic impulse of a continuous kind, but with amplitudes of the waves so steep as to appear discontinuous. Anyway, the light resulting from the impulses of the energy quanta is still of the ordinary kind with transversal vibrations which can be polarised, have wave length, &c. &c., and the mechanism of the transformation of the quanta into the well-known harmonic motion leaves one's mind guessing and groping for an image like a stick striking a drum or anything more tangible than a mere quantity, quantum or impulse. The conception of the Bohr theory is of great general interest to mankind. Its application to the various spectrological phenomena is too much in a special field for anything but a short mention here. It might be mentioned, however, that the author treats the Zeeman and Stark effects, or the influence of magnetic and electric fields on the spectral lines, in the light of this new theory. That it can be made to fit everything is pointed out with great detail and care by the author, but how much this depends upon the flexibility and adaptability of the theory without necessarily following from the theory itself must be left for the instructed reader to determine. Some people might be unkind enough to remember that the Zeeman effect once upon a time revived the electron or corpuscular theory of light, which eventually had to call to its aid the quantum theory for filling up gaps. Anyway, this explanation of the above effects involves the resolution of the orbital movement of the electron into three linear ones, one of which is affected by magnetism and electricity.

The additions to the Bohr theory by Summerfield and Landé are further "theories" necessary to introduce the required mathematical complexes which make the calculated numerical results agree with observations.

In choosing the historical arrangement of the facts, the author has handicapped himself a great deal, but he keeps the interest of the reader on the alert from beginning to end. Numerical results are tabulated in such numbers that the reviewer must take them as correct, especially as the proof reading has been well attended to. There is such a superabundance of facts given in this book that one can see the necessity for a further subdivision of the matter in a future edition. It is not the author's fault that the Bohr theory becomes loose-jointed in its development for suiting special cases, and he has put that theory before his readers as well as it can be put as yet without abandoning critical discussion for didactic dogmatism which so many other writers adopt. The book is a welcome addition to the text-book literature of to-day.

Bauxite. By CYRIL S. FOX, D.Sc., M.I.M.E., F.G.S. London: Crosby Lockwood and Son. 1927. Price 30s. net.

THE subject of this work presents unusual difficulties for many reasons; on the one hand, bauxite is a somewhat ill-defined mineral substance, and on the other hand, the users of bauxite are few and form a relatively close corporation. Dr. Fox is, however, exceptionally well qualified to write such a book, because he was for some time engaged in investigating and reporting upon the bauxite occurrences of India, and was subsequently able to get into touch with the users of bauxite. Although bauxite is employed for a large number of purposes, its main use is as an ore of aluminium, about three-fourths of the world's output being utilised in this way. The author is definitely of the opinion that bauxite is an aluminous variety of laterite, a view that has been gaining ground steadily for the last quarter of a century, and he quotes with approval a sentence from Dr. W. F. Clarke's Data of Geochemistry: "Between bauxite and laterite there is no dividing line, and one shades into the other."

After a full discussion of the relation of bauxite to the other types of laterite, the physical characteristics and chemical constitution of bauxite are fully considered. Then comes a chapter on the Origin and Formation of Bauxite, the author apparently holding that there are two main modes of origin, namely, decomposition *in situ* of rocks rich in silicates of alumina, which he describes as the laterite type, and residual deposits due to the dissolving away of calcareous rocks and leaving a highly aluminous residue. This latter Dr. Fox speaks of as the Terra-Rosa type.

The mode of occurrence of bauxite in various parts of the world is discussed, and all the world's important occurrences of bauxite are fully described, this being perhaps the most complete and important section of the book. There is a chapter on the mining and marketing of bauxite, which has naturally only quite a temporary interest, and which cannot be said to add greatly to the permanent value of the book. The manufacture from bauxite of a number of substances, such as abrasives, alum, cement, refractories, &c., is briefly considered. A chapter on the Manufacture of Aluminium follows; it deals with the subject in the briefest possible outline, and is necessarily imperfect; it might fairly be said that this chapter should either have been omitted altogether or have been very much extended. The after-treatment of aluminium is hardly considered at all; thus, although aluminium forms, in fact, an ingredient in a large number of alloys dating back to the early days when aluminium bronze was discovered by Dr. John Percy, the only reference to such alloys in the present work is a brief notice of an aluminium-silicon alloy. It need hardly be said, however, that for those who require them other works are available, dealing specifically with the subject of aluminium manufacture, whilst information concerning bauxite is widely scattered and has to be sought for in a number of different works and papers. It may, therefore, be held that not the least valuable portion of the book before us is to be found in the very complete Bibliography with which it concludes. The work will probably form an exceptionally valuable book of reference to all interested in the subject of bauxite for a good many years to come.

SHORT NOTICES.

Time and Motion Study. By Stewart M. Lowry, Harold B. Maynard and G. J. Stegemerten. New York: McGraw-Hill Book Company. 1927. Price 20s.—This is an American book, written for both the student and the works manager. When we read books of the kind—or rather, let us say, "peruse," for surely no one can really "read" them—we find ourselves wondering why one part of them is needed at all, and how anyone can tolerate the other part; for, speaking broadly, they are always divisible into one section which deals with the means of making time studies and another which handles the classification and analysis of those studies when made. With regard to the first, any competent manager should be able to make a time study without the aid of a text book, and, for the second, since every accountant appears to have his own way of analysing the returns, the laying down of any particular scheme is hardly worth while. What is really needed is the reduction of the whole scheme of time and motion studies to a much simpler form. At present, it would almost seem as if the object were rather to provide positions for a staff of clerks, and to afford means for the compilation of endless statistics, than really to get the work along. Already the useful load factor of offices grows less and less; the size of staffs in proportion to the production side is much too high, and rather than increase it, means should be sought for its reduction. These comments are rather of a general nature than directed particularly to the book which lies before us. It seems to follow on fairly familiar lines, and although the "formulas" which occupy the second part appear to be rather forbidding in their length and detail, we have seen others that are worse. The penultimate chapter is devoted to the Group System of Wage Payment, a system which is probably more largely used in America than here. It, at least, is well worth reading and thinking about.

Trade Unions and the Law. By Arthur Henderson, Barrister-at-Law. London: Ernest Benn, Ltd. 1927. Price 8s. 6d. net.—The author does not tell us why he wrote this book and for what class of reader it is intended. We may surmise, however, that its appeal is rather to the employer and the workman than to the law. It gives as briefly as may be a summary of the various Acts affecting trades unions, classified not by the whole Acts but by their section—as, for example, the Right to Strike, Legal Responsibilities, and so on. With regard to Acts which have been in force for some years, the author writes from a study of judgments which have construed those Acts; but when he deals with the Act of 1927 he can only give his opinion of what may happen, under the law, in certain circumstances. The nature of his views may be gauged from the fact that Sir Henry Slesser is the author of a commendatory preface. We need only say that not everyone will share his views. We may add that it would have been better if the little hint of bias which we detect had been rigidly excluded from a book which is presumably intended for a work of reference.

In a Persian Oil Field: A Study in Scientific and Industrial Development. By J. W. Williamson. London: Ernest Benn, Ltd. 1927. Price 7s. 6d.—This is a pleasant book to read; possibly because it is not very technical. Mr. Williamson went out to the oil fields at the invitation of the chairman of the Anglo-Persian Oil Company, and though his visit was brief, he was able to secure a fair knowledge of the works and ways of that great organisation. It is the purpose of the book to show the general, rather than the technical, reader how a great company by its undertakings benefits those with whom it comes into contact. When the Anglo-Persian Oil Company went to Masjid i Seleiman it found a wilderness of crumpled hills peopled by nomads, hyaenas and jackals. To-day, among these same treeless hills, over an area of 200 square miles, there is a settled industrial population of some 30,000 souls, provided with all, or nearly all, the conveniences and amenities of Western civilisation. No less than 1600 miles of roads have been constructed in Persia by the company, and nearly 4000 Persians are engaged constantly in their maintenance. The whole story that Mr. Williamson unfolds is one that proves that civilisation follows the British pioneer. "The writer is not disposed," says our author, "to qualify the exalted view expressed to him that what the Anglo-Persian Oil Company has done in Persia is one of the finest achievements associated with the British name. It is a great game finely played, and the spectator must be dull who is not thrilled by it and apathetic if he does not feel, while watching the game, some longing to be a participator in it."

BOOKS RECEIVED.

B.B.C. Handbook, 1928. London: George Newnes, Ltd., 8-11, Southampton-street, W.C. 2. Price 2s. net.

Trade. By E. J. P. Benn. London: Ernest Benn, Ltd., Bouverie House, Fleet-street, E.C. 4. Price 6d. net.

U.S.S.R—A World Enigma. By Iva Lee. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 6s. net.

Einzelantrieb von Werkzeugmaschinen. By Karl Meller. Leipzig: S. Hirzel, Königstrasse 2, Germany. Price 15 marks net.

The Ship Under Steam. By G. Gibbard Jackson. London: T. Fisher Unwin, Ltd., 154, Fleet-street, E.C. 4. Price 10s. net.

University of London College Calendar, Session 1927-28. London: Taylor and Francis, Red Lion-court, Fleet-street, E.C. 4.

British Rainfall, 1926. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 15s. net.

Electric Winders. By H. H. Broughton, M.I. Mech. E., &c. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 52s. 6d. net.

Der Kugelschlaghärteprüfer. By Dr.-Ing. J. Class. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 3 marks.

Studies in Naval Architecture: Strength-rolling. By A. M. Robb, D.Sc. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C. 2. Price 25s. net.

The Design of Merchant Ships and Cost Estimating. By Alexander Kari. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 36s. net.

Manual of Forest Engineering and Extraction. By J. F. Stewart, F.R.S.G.S. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

Machines et Appareils Electriques. Vol. II. By L. Bouthillon and M. Goudonnet. Paris: (6e), Gauthier-Villars et Cie., 55, Quai des Grands-Augustins. Price 20f. net.

Les Lois Fondamentals de l'Electricite. Vol. I. By L. Bouthillon and M. Goudonnet. Paris: (6e), Gauthier-Villars et Cie., 55, Quai des Grands-Augustins. Price 14f. net.

Brassey's Naval and Shipping Annual, 1928. Edited by Sir Alexander Richardson and A. Hurd. London: William Clowes and Sons, Ltd., 94, Jermyn-street, S.W. 1. Price 25s. net.

The Workmen's Compensation Acts, 1925 *and* 1926. Twenty-fifth edition. By W. A. Willis. London: Butterworth and Co. (Publishers), Ltd., Bell-yard, Temple Bar, W.C. 2. Price 15s. net.

Manual of Electrical Undertakings and Directory of Officials. Vol. XXX., 1926–27. Edited by F. C. Garrett. London: The Electrical Press, Ltd., 13, Fisher-street, W.C. 1. Price 35s. net.

Power-house Extensions at Stoke-on-Trent.

On Monday last the recently completed extensions of the Central Power-house of the city of Stoke-on-Trent were formally put into service, the Mayoress turning on steam to the latest installed and the largest turbo-alternator set in the building.

The electricity undertaking, of which the generating station at Stoke-on-Trent forms a part, had its origin as long ago as the year 1894, when the Corporation of Hanley started to supply electricity from a small station containing two 50 kW and one 100 kW alternators, rope-driven by steam engines, the alternators generating single-phase 100-cycle current at 2000 volts. To the original plant, sets of 300 kW and 600 kW were subsequently added.

Later than Hanley, three other Pottery towns—Longton, Stoke and Burslem—built electric generating stations, and all three of them installed direct-current machines. That fact was made full use of by the opponents of the step when the proposal to federate the six Potteries towns came before Parliament in 1908. In spite of that, however, the towns were duly federated on March 31st, 1910, under the title of the County Borough of Stoke-on-Trent, and the electricity supply came under common management at the beginning of September of the same year.

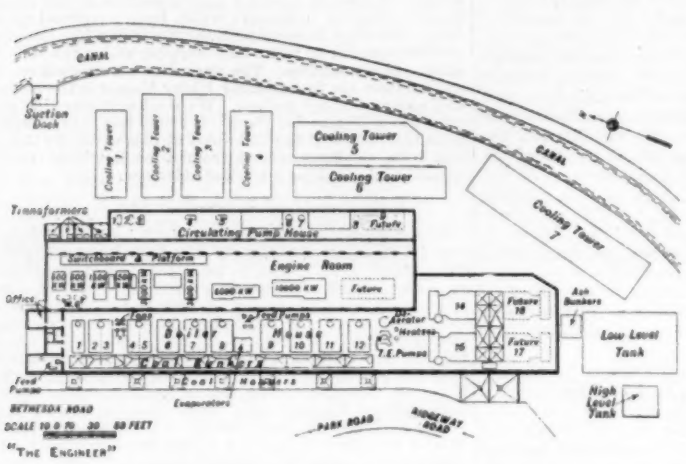
Early in 1911 the Electricity Supply Committee of the federated area had to find answers to the following questions:—How best to provide the additional power required in the district? What was the best means of linking up the four existing works? and How to generate and distribute the energy in the most economical manner? As the result of careful investigation, the Committee recommended the Council to construct an entirely new station, at which extra high-tension three-phase, 50-cycle current might be generated for transmission by trunk mains to the four existing stations, where its tension was to be lowered for local distribution. The proposal was adopted, and, the sanction of the Local Government Board having been obtained, the construction of what was, and still is, called the Central Power-house was begun at the latter end of the year 1911.

At first the equipment consisted of two 1500 kW turbo-alternators, and on April 1st, 1914—a few months before the outbreak of the Great War—the four existing electricity undertakings were combined. During the period of hostilities all demands for current were met, but before the war came to an end it had become evident that the demand for power was increasing so fast that it was necessary to provide additional generating capacity. Accordingly, a third turbo-alternator—this time a 3000 kW machine—was ordered, and it was put to work in March, 1919. As the demand continued to increase, a further 3000 kW set was started in 1922. It soon was realised, however, that even these additions were unable to cope with the growing load, so two 1000 kW turbo-alternators were, in January, 1923, installed, one in each of the Burslem and Stoke sub-works, where they displaced small and relatively inefficient sets.

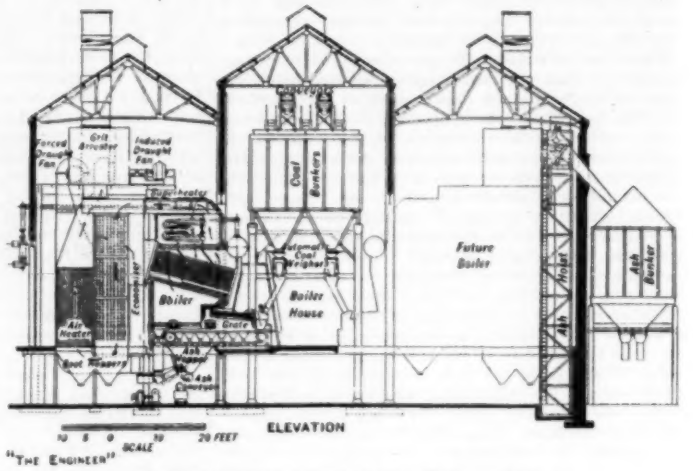
Still the demand grew, and some two and a-half years later a 6000 kW turbo-alternator was installed at the Central Power-house, and now—only two years later—the 10,000 kW set, which forms part of the present extensions, has had to be put to work. From an exceedingly interesting brochure which was prepared—by, we think we are right in saying, the able city electrical engineer, Mr. C. H. Yeamen—for distribution at the opening ceremony, we learn that whereas, in the year 1912–13 6,889,479 units of electricity were generated and 20,718 tons of coal were consumed, in the year 1926–27, by reason of the use of more efficient plant and improved operation, as many as 22,525,329 units were generated at a cost of only 29,492 tons, the consumption of coal having been brought down in the intervening fourteen years from 6·74 lb. per unit generated to 2·23 lb. per unit.

The present extensions have been carried out in accordance with the recommendations contained in a report by Mr. Arthur Ellis, M. Inst. C.E., to whom the question as to the maximum capacity that could economically be placed upon the site was referred in 1925. The new buildings were designed by Mr. A. Burton, M. Inst. C.E., the city surveyor, and erected by Messrs. C. Cornes and Son, of Hanley, with Redpath, Brown, Ltd., of Manchester, as sub-contractors for the structural steel work. They include an extension of the pre-existing engine-room, with a short extension of the pre-existing boiler-house, and a complete new boiler-house. The engine room has been extended by 128ft. to 320ft. in length, and the height from the basement to the apex of the roof is 62ft. Owing to the necessity of installing larger boilers than those previously used, it was necessary to arrange the new boiler-house at right angles to the older building. The new structure, which has three bays with three roof spans, has a width of 117ft., a length of 87ft., the height to the apex of the central roof being 77ft.

The two new boilers are each designed for a normal output of 60,000 lb. of steam per hour at a pressure of 260 lb. per square inch, and a temperature of 660 deg. Fah. from water at 150 deg. Fah., the overload rating being 80,000 lb. of steam per hour. The guaranteed efficiency on normal duty is 86 per cent., while the final temperature of the gases passing to the chimney is guaranteed not to exceed 250 deg. Fah. These boilers, which were supplied by Babcock and Wilcox, Ltd., are of that firm's cross-drum marine water-



PLAN OF STOKE-ON-TRENT CENTRAL POWER HOUSE



SECTION THROUGH EXTENSION BOILER HOUSE

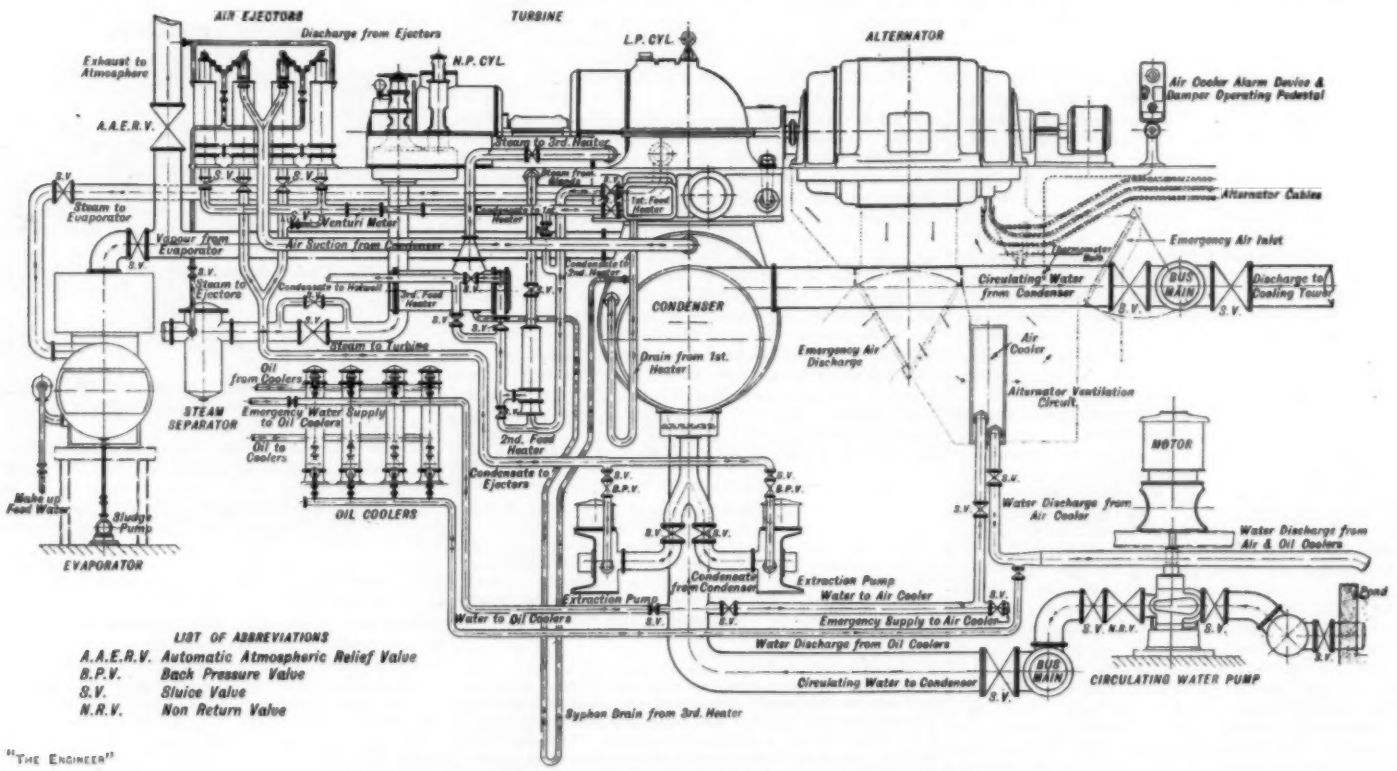


DIAGRAM OF PIPE CONNECTIONS OF 10,000 K.W. TURBO-ALTERNATOR

tube type, with integral superheater, economiser, air heater, Davidson grit arrester, and induced and forced draught fans. Each has a two-compartment chain-grate stoker, each having an effective grate area of 288 square feet. The heating surface of each unit is made up as follows :—

	Square feet.
Boiler	9,618
Superheater	980
Economiser	6,048
Air heater	11,760
Total	28,406

The economisers were supplied by Greens of Wakefield, and their tubes and headers are of that firm's "Tri-tube" type. Each boiler is fitted with the Hagan system of automatic control, and the operation of the boilers will be fully automatic. If the steam pressure starts to fall, the draught pressure and the rate of coal feed are increased, and *vice versâ*. There are two new boiler feed pumps, both made by G. and J. Weir, Ltd., of Glasgow. Each has a capacity of 120,000 lb. of water per hour against a pressure of 345 lb. per square inch. The new steam piping, which was supplied by the Brightside Foundry and Engineering Company, Ltd., of Birmingham, is of solid-drawn steel with welded-on flanges. A de-aerator, which has a capacity of 250,000 lb. of water per hour, with its oxygen content reduced to less than 0·08 cubic centimetre per litre has been installed by Hick, Hargreaves and Co., Ltd., of Bolton. The new steam valves were supplied by Messrs. Hopkinson, of Huddersfield, and the new water valves by Messrs. Blakeborough, of Brighouse.

The new 10,000 kW turbo-generator, with its surface condensing plant, were made by the Metropolitan-Vickers Electrical Company, Ltd., of Manchester. The turbine, which is of the impulse type, is designed to carry a normal load of 10,000 kW, with a stop valve steam pressure of 250 lb. per square inch and a superheat of 250 deg. Fah., *i.e.*, a total steam temperature of 650 deg. Fah., its guaranteed full-load steam consumption being 10·047 lb. per unit. It has an overload capacity of 12,500 kW—which is equivalent to just over 16,650 H.P.—with a slightly higher steam consumption. It is a two-cylinder tandem turbine, the high-pressure cylinder and valve chest being of steel throughout. The steam inlet is controlled by automatic valves which are themselves controlled by oil pressure from an automatic governor, while the main valve is furnished with motor-driven mechanism by means of which the turbine load and speed can be controlled from the switchboard. The main turbine is bled, from the low-pressure stages, both for heating the boiler feed and for evaporating crude water to make it suitable for boiler feed. The evaporator will supply 4000 lb. of chemically pure air-free water per hour. There are two feed-water heaters, each of which will raise the temperature of the boiler feed water up to 180 deg. Fah.

The alternator is designed for a total load of 10,000 kW at 0·8 power factor, 50 to 51½ periods, at 6600 volts. It is of the maker's standard design, with steel slip rings, an overhung exciter, and a closed circuit system of air cooling. The condenser is of the radial flow surface type of an entirely new design. It is mounted on a spring suspension immediately below the exhaust end of the turbine, and it is designed to maintain an absolute pressure of 1·6in. of mercury—corresponding to a 28·4in. vacuum—when supplied with cooling water at 70 deg. Fah. Air extraction is effected by two-stage steam jet air extractors, with surface intercoolers, the air ejectors being in duplicate and each designed to deal with 54 lb. of saturated air per hour. The condensate is extracted by two specially designed Mather and Platt rotary pumps, each of which is capable of dealing with all the condensed steam from the turbine. The pumps are each driven by a vertical three-phase motor of 24 H.P. running at 1450 r.p.m.

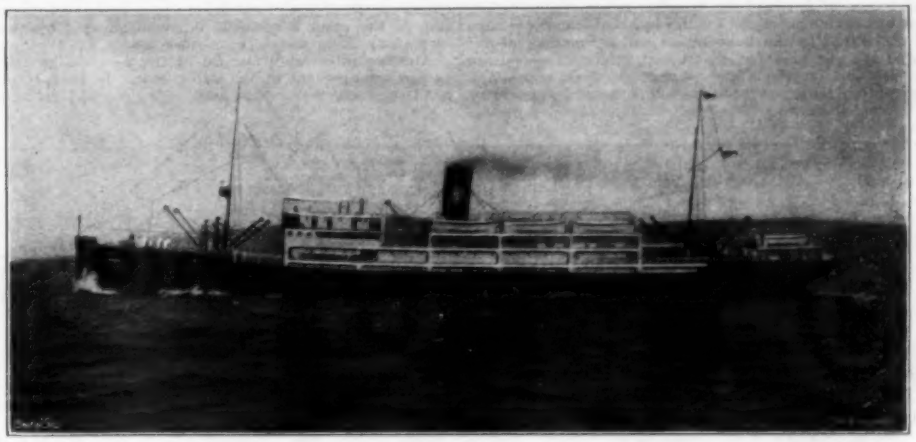
The cooling water is circulated through the condenser by either or both of two vertical centrifugal Mather and Platt pumps, each of which is driven by a 161 H.P. Metropolitan-Vickers, three-phase, vertical motor at 1000 r.p.m. Each pump is intended to deliver 460,800 gallons of water per hour against a water head of 56ft. To reduce the temperature of the circulating water, a cooling tower has been erected by the Davenport Engineering Company, Ltd., of Bradford. It is of the natural draught, two-chimney type, and is designed to deal with 400,000 gallons of water per hour, reducing the temperature from 88 to 74 deg. Fah., with an atmospheric wet-bulb temperature of 55 deg. Fah.

The addition to the plant of this large new unit has necessitated alterations and extensions in various parts of the station. New E.H.T. switchgear had to be supplied for the machine, and it was furnished by the Metropolitan-Vickers Company, together with gear for a new 800 kVA station transformer, for four new feeders, &c. The new switchgear for the supply of L.T power to the station auxiliaries was made by A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, while the extension coal and ash-handling plants were manufactured and installed by J. W. Jenkins, Ltd., of Retford. Considerable extensions have also been made in the transmission and distribution cable systems.

The accompanying illustrations show a plan of the station as it now exists, a cross section through the extension boiler-house, and a diagram showing the arrangement of the new 10,000 kW set and its auxiliaries.

THE BRAZILIAN MOTOR VESSEL ITAPÉ

WILLIAM BEARDMORE AND CO., LTD., DALMUIR, BUILDERS AND ENGINEERS



The Motor Passenger and Cargo Vessel Itapé.

REFERENCE has already been made in our Seven-Day Journal columns to the three motor vessels which are being constructed by William Beardmore and Co., Ltd., at Dalmuir, to the order of the Companhia Nacional de Navegacao Costeira, of Rio de Janeiro, for that company's service on the eastern coast of South America northward from Buenos Aires. On Wednesday of last week, November 2nd, the first ship to be completed, the Itapé, ran successful trials in the Firth of Clyde, when a large party of guests, representing shipping and engineering interests, were present. In what follows we give an account of the general arrangement of the passenger and cargo accommodation of the vessel, together with illustrations of her machinery arrangement. The main engines are of particular interest because they are the first of their kind to be constructed in this country. They were designed and

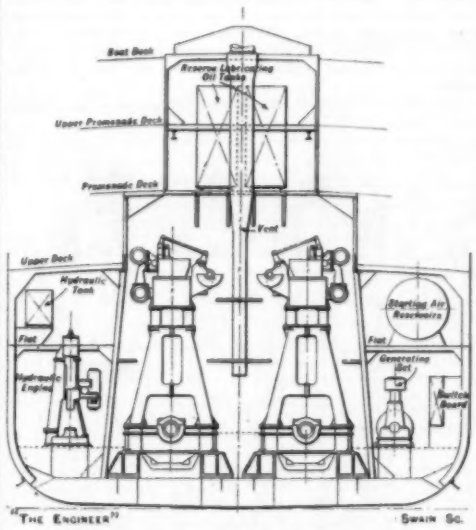


FIG. 1—SECTION THROUGH ENGINE-ROOM

built by Beardmore's Diesel engine department at Dalmuir, the design being based on successful past experience with engines of the Beardmore-Tosi four-cycle single-acting type.

Hull Particulars.—In the illustration above we show the ship as she appeared on her trial run. The vessel has a straight stem and elliptical stern, and is rigged as a fore-and-aft schooner with two pole masts. A single funnel serves to accommodate the exhaust silencers for the main engines and to carry the uptakes from the two boilers which are provided to raise steam for auxiliary and heating purposes. The Itapé was built under special survey to Lloyd's 100 A 1 class, with freeboard, and as regards safety appliances and navigational equipment, she embodies the latest practice. The principal dimensions of the ship are given in the following table :—

Length between perpendiculars	370ft.
Breadth moulded	52ft.
Depth moulded	26ft. 9in.
Loaded draught	20ft.
Deadweight carrying capacity	3800 tons.
Trial speed	14½ knots.
Approximate gross tonnage	5000.

The ship has continuous upper and main decks, with a lower deck forward and aft of the amidships machinery space. There is also a long forecastle, with combined poop and bridge decks, as well as upper promenade and boat decks. For the size of ship the passenger accommodation is unusually good. On the upper deck and promenade deck are forty-nine state rooms, mostly of the three-berth type, with provision for 145 first-class passengers. The first-class public rooms include a dining saloon on the upper deck with tables to seat 127 passengers. On the promenade deck there is the first-class music-room forward and a smoking-room with a verandah café at the after end of the same deck. At the after end of the upper deck cabin accommodation is provided for forty passengers of intermediate class, with a separate dining saloon and a smoking-room and entrance on the promenade deck above. There is further provision for ninety third-class passengers at the forward end of the main deck.

Cargo Holds and Auxiliary Machinery.—The cargo holds are five in number, three forward of the machinery spaces and two aft of them, while in the fore and after peaks there are, in addition to the double-bottom tanks, tanks for fresh water and water ballast. The main oil fuel tanks are also arranged in the double bottom and there are two side tanks in the boiler-room wings, immediately forward of the main engine-room. In addition to the holds referred to, one of which—No. 3—is specially equipped for the carrying of salt, there are three large refrigerated compartments with a total of 20,000 cubic feet capacity, including a refrigerated chamber for the ship's provisions. A refrigerating plant of the CO_2 type, supplied by J. and E. Hall, Ltd., of Dartford, is fitted. Two of the refrigerated chambers are air-cooled for the carriage of fruit.

The cargo-handling plant is of a somewhat unusual type, hydraulic cranes, built by Brown Brothers, of Edinburgh, being fitted instead of cargo winches. There are ten such cranes, eight being designed each to lift 30 cwt. and two at the double hatches of the second hold forward, each to lift 3 tons. An electro-hydraulic steering gear, also made by Brown Brothers, is installed. The remaining deck auxiliaries comprise an Emerson-Walker steam windlass and a Clarke-Chapman electric warping winch and boat winch. There are seven lifeboats which are carried in ordinary davits furnished with turning-out gear.

Main Propelling Machinery.—The main propelling machinery is situated amidships and comprises a twin-screw arrangement of six-cylinder, four-stroke cycle, single-acting engines, of the Beardmore-Tosi pattern, specially designed to work with supercharging or augmented induction. The cylinders are each 26in. in diameter, with a stroke of 43½in. In normal service each engine is designed to develop an output of 1650 B.H.P. when running at 130 r.p.m., but when running supercharged this output can be increased to 1850 B.H.P. at 135 to 140 r.p.m. When testing the first engine it was found possible, we understand, to maintain an output of 2200 B.H.P. without difficulty with a clear exhaust and with normal combustion and exhaust temperatures, and during the trials an output of over 4000 S.H.P. for both the engines was demonstrated.

From the elevation and plan of the machinery spaces, reproduced in Figs. 1 and 2, a general idea of the lay-out of the main engines and the various auxiliaries will be obtained. The auxiliary machinery includes both steam and electrically operated units, the current for the electrically driven sets being generated from two Allen 110-kW, 450 r.p.m., compound steam generator sets, arranged in the port wing of the main engine-room. Near to the generator sets and aft of them are two Weir steam-driven auxiliary compressors, each designed with a capacity of 130 cubic feet of free air per minute. These units run at 415 r.p.m. On the same side of the engine-room is the Weir steam-turbine driven supercharging blower, designed for a normal capacity of 13,700 cubic feet of free air per minute. During the trials a supercharging pressure of from 24in. to 25in. water column was employed. The blower delivers air into an air induction tank, which runs athwartships, with connections to the induction manifolds on each engine. Valves are provided to cut off the supercharging air if so desired. Along the forward and after bulkheads are arranged the boiler feed pumps and the pumps for the cooling water services. Two separate cooling water services are employed on the main engines. For the cylinder jackets, exhaust pipes and main air compressor sea water cooling is used, while fresh water is supplied to the pistons, cylinder covers and exhaust valves. The fresh water is pumped from a special tank in the double bottom, and passes through coolers to the engine. It is returned from the engine to the double bottom tank. We need hardly refer in detail to the lubrication pumps, general service, bilge, sanitary and fresh water pumps, which are shown in plan in Fig. 2. On the starboard side of the engine-room there is an engineers' workshop and store, the corresponding space on the port side being taken up by the two starting air receivers.

Other auxiliaries in the main engine-room include the refrigerating machinery and the hydraulic pumps.

In the boiler-room, which is divided from the main engine-room by a screen bulkhead at its forward end, there are two Scotch boilers which are arranged to burn oil fuel under the Wallsend-Howden forced draught system. The forced draught fan is of the Howden steam engine driven type, one engine acting as a stand-by. Oil transfer pumps are also fitted in the boiler-room and "Pneumercator" gauges are provided for all oil fuel tanks. In separate compartment on the upper promenade deck above the engine-room there is a petrol-paraffin emergency generator set, with a special compartment for the fire-extinguishing apparatus.

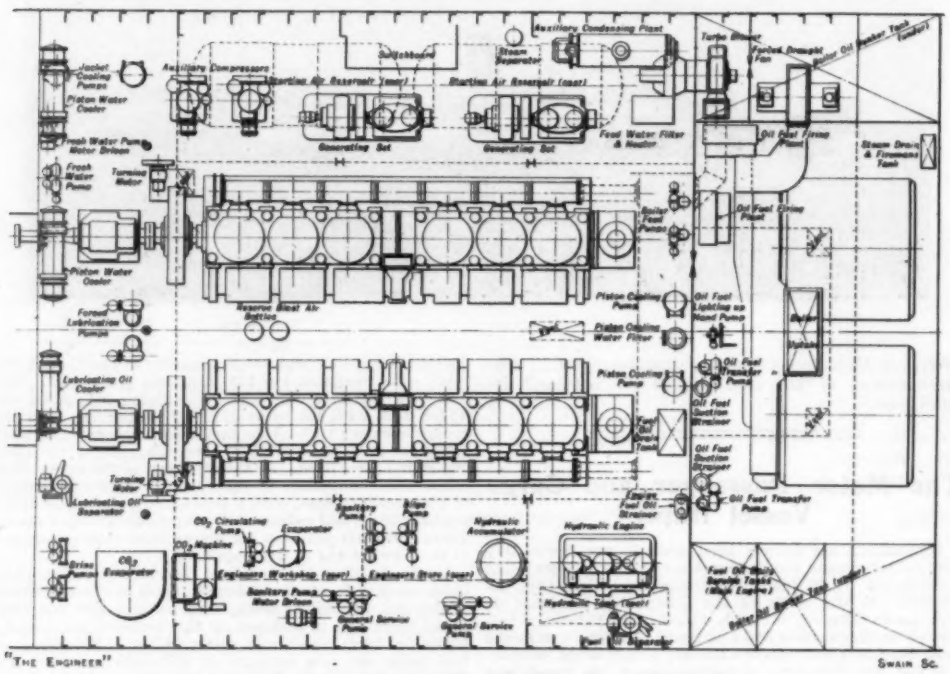


FIG. 2—GENERAL ARRANGEMENT OF PROPELLING MACHINERY

Engine Design and Trial Results.—A front and end view of one of the main engines of the Itapé is shown in Fig. 3. From this drawing it will be seen that a robust type of A framing has been employed. The crosshead girders are of the four-slipper type, which the makers consider preferable to the ordinary single-slipper guide plate with astern bars. A departure from previous designs is to be noted in the arrangement of the cylinders and valve gear. The cylinders are divided into two groups of three, and are arranged in a cast iron entablature, the two parts of which, when bolted together, forms a stiff top girder above the main engine frames. Further structural strength is given by through-going tension bolts. A built-up type of crank shaft is employed, the crank pins and main bearing journals being shrunk into the crank webs. At the forward end of the crank shaft is an extension which drives the three-stage air injection compressor. The compressor is fitted with a crosshead and each cylinder has a separate cast iron liner. Access to the running parts of the main cylinders is given by light inspection doors of large size. From the section through the cylinder shown in Fig. 3 it will be seen that a diaphragm plate is provided under the lower end of the cylinder liner, which effectually prevents any carbon deposit reaching the lubricating oil in the main crank chamber. The piston cooling system is of the jet type, and it embodies the Beardmore system of unpacked water pipes, which are enclosed in a cast iron chamber, the object of which is to prevent any contamination of the main lubricating oil, which might be caused by water leaking into the crank case spaces.

Another interesting feature of the new design relates to the arrangement of the valve gear. In each cylinder head there are five valves, comprising the fuel valve, two combined Tosi type inlet-exhaust valves, along with a starting air valve and a relief valve. Referring to the right-hand view in Fig. 3, it will be seen that the valves receive their motion through pull rods, actuated by levers pivoted on a fulcrum shaft mounted just above the main cam shaft. Such an arrangement permits the cam shaft to be carried along the front of the engine at a somewhat lower level than usual, which permits any cylinder to be opened up without having to interfere with fulcrum shaft and its levers, and without disturbing the timing of the valves.

The control station is arranged at the centre of the engine alongside the fuel pumps. There are two starting levers to each engine, and each of these levers controls three cylinders. By means of an auxiliary air cylinder which works a system of levers the excentrics on the fulcrum shaft are rotated, enabling either of the two groups of three cylinders to be run on air or fuel as desired. The operation of reversing is carried out by an ordinary Brown's reversing engine which moves the cam shaft fore and aft into the ahead and astern running positions. Interlocking gears are fitted which prevent the engine being reversed when the valves are in a neutral position, and arrangements are made to cut out the fuel pumps when the engine is running on air during either starting or manœuvring operations. During the trials the machinery was shown to respond to the various controls, and it was noticeably quiet in running, the smoothness of running being doubtless contributed to by the arrangement of the supercharging air manifolds.

The trials were satisfactory, and over half a knot in excess of the trial speed was obtained.

The following is a summary of the trial results, which has been placed at our disposal by the builders:—The average speed was 14·828 knots; the average total indicated horse-power of the main engines was 5450 at a mean speed of 140 r.p.m.; the fuel consumption of the main engines worked out at an average of 0·407 lb. per brake horse-power hour supercharged.

The Itapé is the first of three ships to be delivered, and the two other vessels, the Itaquicé and Itanagé, are now launched and are in course of being fitted out at Dalmuir. These vessels form a part of more than twelve such ships which have been ordered by the Companhia Nacional de Navegacao Costeria, of Rio de Janeiro, and the Lloyd Nacional of the same city. The other ships are being constructed in France and Italy, but there is no doubt that the Clyde-built vessels will, by reason of their supercharged oil engine machinery, form an economical and important group in this new standard fleet for South American service.

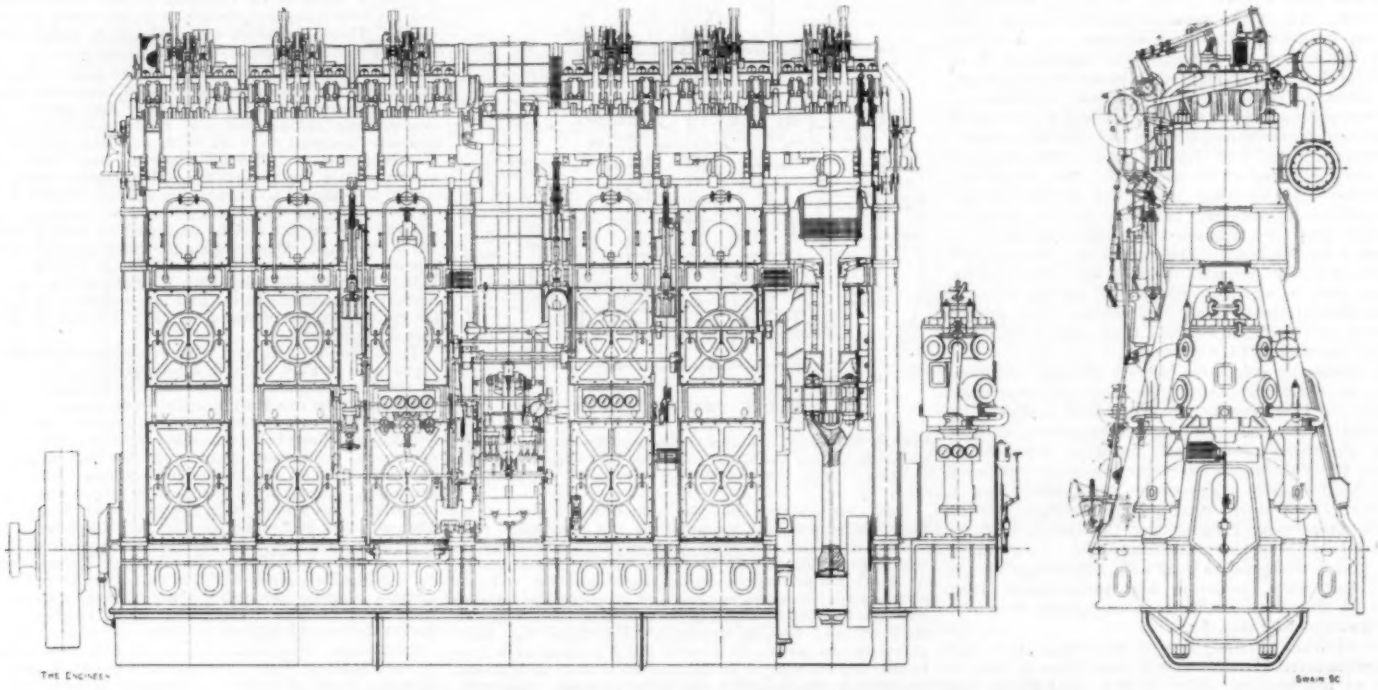


FIG. 3—1850 B.H.P. BEARDMORE-TOSI SIX-CYLINDER SUPERCHARGED MARINE OIL ENGINE

A Boiler Explosion.

One of the most recent official boiler explosion reports deals with the failure of a single-ended boiler, on board a small trading steamer, which resulted in the death of four men, and is a glaring example of the necessity for the proper inspection of all steam generators.

The boiler was 10ft. 3in. in diameter by 9ft. long, and was worked at a pressure of 135 lb. per square inch. It was twenty-five years old, but had not been regularly inspected for a period of four years, excepting such examination as may have been carried out by the late chief engineer. The explosion was caused by the failure of the bottom plate of one of the combustion chambers, producing a hole 2ft. 1in. in length by 15in. maximum width, through which the contents of the boiler were discharged, and scalded the four men in the stokehold.

Considerable repairs had been made to the boiler during the past ten or twelve years, and electric welding had been resorted to several times to strengthen the plating of the combustion chamber, which was apparently so thin that at least on one occasion a scaler drove his hammer right through it.

In his report on the accident the Board of Trade surveyor says:—"I made my way to the stokehold, and found the platform of the passage-way between the engine-room and stokehold and most of the stokehold platform lying in the bilges. The whole of the fittings, bridge, firebars, &c., were lying about the stokehold. The furnace front had been blown off and the smoke-box door had been blown open, and had remained in the open position by being jammed against the stokehold bulkhead. On going into the starboard combustion chamber, I found the bottom plate had ruptured athwartships, for a length of 2ft. 1in., with a maximum width at the centre of 15in., which gradually tapered to each end until it ended in a crack. The thickness of the material at the edges of the fracture varied from $\frac{1}{4}$in. at about the middle 3in. of its length to $\frac{3}{8}$in. at each end. The original thickness is not known definitely, as the firm who made the boiler are now out of business, and a drawing of the boiler could not be obtained. The greatest thickness now measures $\frac{3}{8}$in., so that, allowing for slight wastage, the original thickness was probably about $\frac{7}{16}$in. Immediately behind the fracture, *i.e.*, between it and the combustion chamber back plate, there remained a crust of salt and ashes to the depth of about 9in., measured from the centre of the combustion chamber bottom. No doubt this crust had been fairly uniform

over the whole of the combustion chamber bottom, but most of it had been blown out by the force of the explosion.

"The appearance of the plate which ruptured was such as might deceive anyone making but a casual inspection, as the thickness of the plate could not be determined visually, owing to the uniformity of the corrosion which is usually associated with that caused by a layer of damp salt. The presence of the latter, however, and the fact that holes had already appeared in each of the combustion chamber bottoms, and had been filled up by electric welding, should have been sufficient indication to anyone that the thickness of each of these plates was at least suspect, and steps should have been taken to ascertain the actual thicknesses by drilling."

In his observations the engineer surveyor-in-chief says:—"The case is an instance of the casual way in which some boiler owners treat their steam plant, and of the terrible consequences which may be the result of such conduct. It is also to be expected that when a person, having knowledge and experience of boiler maintenance, makes any examination of a boiler, he would take into consideration its age and the conditions under which it worked. The repeated repairs to the chambers by welding would be evident in this case, and should have been a warning to the inspector.

"The case also suggests that the indiscriminate use of a process for depositing metal upon wasted surfaces and other defective parts may be dangerous, and that the scope of such methods of repair should be confined to cases where the wastage is not widespread and has not affected the strength of the part seriously."

Conference of Czech Engineers.

THE Association of Czechoslovak Engineers and Architects recently held its seventh congress at Mladá Boleslav, in N.E. Bohemia. The proceedings of the conference have just been published* and form an impressive record of the achievements of the members covering the whole field of engineering science.

One of the largest engineering undertakings in the world is the Skoda Works at Plzen (Pilsen), which also has a branch at Mladá Boleslav, where especially motor cars and cycles are built. This branch was formerly known as the firm of Laurin and Klement, and its history is related in the *Almanac*. Much attention was given at the conference to the history and development of the motor industry and of automobilism in Bohemia. Not only was much attention paid to the latest types and constructions but several members referred to the question of motor fuel. So far as Czechoslovakia is concerned, it appears that the use of power alcohol will extend in the future. One member advocated the use of ether as a fuel. Interesting descriptions were given of various Czechoslovak industries. Of outstanding importance to the country is the sugar industry. The practice followed at the sugar factories at Dobrovice, Dolni Cetno, Sadska, &c., is given by the chief engineers of those establishments. Closely connected with the production of refined sugar is the cultivation of the beet. The report of the director of the Semcice Experimental Station for the improvement of beet cultivation is of some significance. By careful seed selection and growing the sugar content of the roots has been raised to 20 per cent. Success has also attended the efforts to eradicate various pests and diseases to which the plants have been subjected. Among the other industries which are described, mention may be made of the gem cutting trade of Turnov, the Jablonec (Gablonz) glass trade and the various textile industries in North Bohemia, which are reviewed by prominent specialists.

Another subject which received attention at the conference is long-distance telephony. An explanation was given of the construction of the wireless stations equipped for this work. The essentials for good transmission of speech by both cable and wireless were outlined and the broadcasting stations of Prague, Brno and Bratislava were described from a technical point of view.

The chemical engineers were particularly prominent at this conference, and under the chairmanship of Professor Cyrill Krauz they contributed thirty-one papers out of a total of the 112 read at the conference. Of these, nine are from members of the Czechoslovak Army Services. They deal with the past and future applications of poison gases in warfare, the manufacture of explosives and the technical application of chemical science to military needs. This section was also concerned with the development of the power alcohol industry.

During the conference a number of works visits were made and there was an excursion to Podebrady, one of Czechoslovakia's two hundred health resorts. The chalybeate spa water from some of the springs is now being bottled under the name "Podebradka."

Altogether the *Almanac* gives a great deal of information—unfortunately in Czech—concerning the various engineering and allied industries. The volume reflects great credit upon those responsible for its publication.

A Rotary Sight Feed Lubricator.

WE recently inspected at the offices of Mr. E. T. White, of Clare House, 57, Kingsway, London, W.C. 2, a rotary type of positive sight-feed lubricator, which has been designed for use on locomotives and oil or steam engines, both of the land and marine types. The general appearance of the lubricator is shown by Fig. 1, and in Fig. 2 we reproduce two sectional views, which clearly show the principal working parts. The apparatus consists of a rectangular oil chamber fitted with a hinged cover and a strainer, to which a gear type pump driven by a ratchet wheel and lever, is directly attached. The oil box, which is a casting with ¼in. thick walls, is provided with three supporting feet, and to the front of it is attached the distributor bar with the multiple sight feed delivery connections. As many as twelve delivery connections can be fitted to a single lubricator. In the bottom of the oil box there is a copper heating coil with outside steam connections. Directly above the pump is arranged a relief valve, which by-passes any surplus oil back to the chamber from which the pump draws its supply. On the bottom side of the feed bar there is arranged a number of feed-adjusting

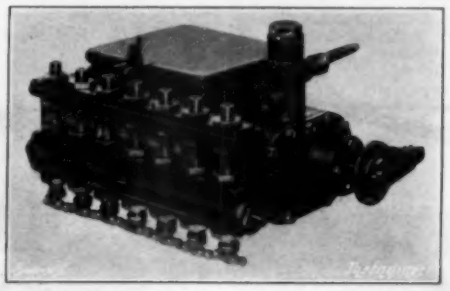


FIG. 1—SIGHT FEED LUBRICATOR

screws, which can be easily set and locked. A wide range of flow through the sight feed control valves is given, varying from one drop every two minutes to one drop per second. A feature of the lubricator is the delivery of oil twelve times during each revolution of the pump spindle, which under normal running conditions amounts practically to a continuous supply. Another advantage which is claimed by the maker is the small number of working parts, and the fact that practically all of them work in an oil bath. The design is such that the sight-feed controls may be placed adjacent to the lubricator or may equally well be mounted in a locomotive cab or on the control platform of an engine at some distance from the lubricator itself. The general design is simple in character, and easy access is given to the oil chamber by unscrewing a ¼in. hinged wing nut, which enables the cover to be thrown back and the removable oil strainer tray to be inspected.

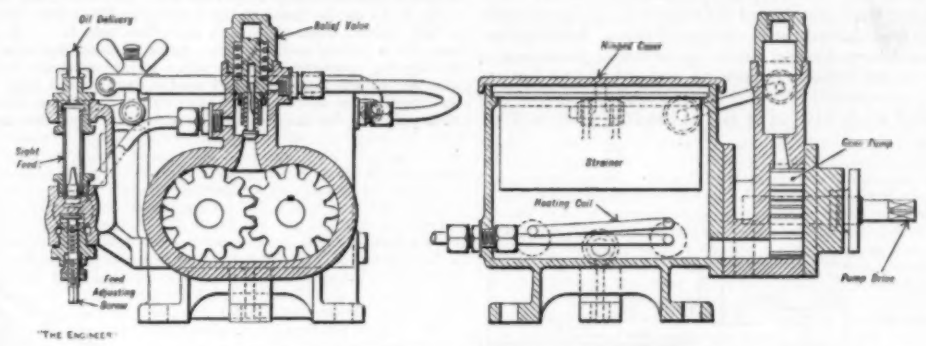


FIG. 2 SECTIONS THROUGH ROTARY SIGHT FEED LUBRICATOR

*Almanach VII. Sjezdu Ceskoslovenskych Inzenyru a Architektur 1927 v Mladé Boleslavi. Pp. 432, profusely illustrated.

Books of Reference.

"GARCKE'S Manual of Electrical Undertakings." Vol. XXX. 1926–27, has just reached us, and it proves to be just as imposing a volume as have been its precursors of recent years. Indeed, it is larger than any that have gone before it. It now comprises some 2000 pages, with twenty-six maps, and it gives particulars of about 4000 electrical undertakings and the names and addresses of some 20,000 officials. In order to show the enormous growth of the industry with which it deals, it contains a table setting out the capital invested in electrical supply, year by year, since 1896, the year in which the book was first published. Then, some 200 undertakings were included and their combined investments amounted to £61,109,525. By the year 1926–27, the amount invested had grown to £810,824,179. During the intervening period "Garcke" has given annually a progressive account of the growth, and it is now, justly, regarded as the authoritative record of the electrical industry. It is, indeed, far too well known to require any further words from us, saving to say that it is published by the Electrical Press, Ltd., 13–16, Fisher-street, Southampton-row, London, W.C. 1, and that its price is 35s. net

"MOTORSHIP Manual and Register of Motor Vessels, 1927." *Motorship*, 220, West 42nd-street, New York. Price 3 dollars, or 12s. 6d.—The "Motorship Manual" for 1927 is larger than the "Motorship Yearbook" of last year, which it succeeds. Out of a total of 288, there are over 250 editorial pages, which are excellently illustrated. Those who were privileged to hear the editor, Mr. A. C. Hardy, lecture on "Motor Vessels and Trade Routes," before the Institute of Marine Engineers at Olympia recently, will be familiar with the ideas expressed in the first articles on a new era of motor shipping and world route charts for motor ships. A list of motor ships converted up to June, 1927, under the United States Shipping Board's scheme is given, and thereafter follows an illustrated survey of the principal motor vessels which have been completed in the period under survey. A short article on American motor ship types completes the first section of the book. In the instructional section there is a short course on the fundamental principles of oil engine design and construction, which is followed by the latest American rules for certificates of licence for engineers of motor vessels. Some fifty pages are devoted to illustrated descriptions of various types of marine oil engines of American, British and continental origin, in which the standard sizes of engines built by the different firms are enumerated. After some further short articles on laminated Babbitt insert shims, lubrication, oil centrifuging, pump equipment and air filters, there follows a complete list of the oil bunker stations of the world. Another similar table gives the radio beacons of the world in 1927, and it is preceded by three articles dealing with the electrical equipment of motor vessels. The Diesel engine classification rules for Lloyd's Register and the American Bureau of Shipping are reprinted, and appended are some useful conversion tables and constants. The "Manual" concludes with a register of all vessels fitted with oil engines having a total power over 300 S.H.P., which, of course, includes a number of the smaller motor ships which are not usually given British tables. The vessels are arranged in alphabetical order according to the year in which they were built, and in a name index is also provided. The book should be both interesting and valuable to all who may wish to follow the present and future development of the motor vessel.

"BRITISH Rainfall, 1926."—The volume, which is the sixty-sixth of the series, contains a full account of the rainfall of the year under review. It includes maps, tables and descriptive matter showing the distribution of rainfall in each month and for the whole year and its relation to the average; studies of the distribution on individual days of particular interest; discussions of heavy falls of rain in short periods, of the number of days with rain, and of the spells of dry or wet weather during the year. Sections are devoted to the measured duration of rainfall and to record of evaporation of percolation through the soil. Articles on various branches of rainfall research, &c., are also given. The total rainfall for the year at each of 4877 stations is placed on record. The rainfall of the year 1926 over the British Isles as a whole is shown to be similar to that of 1925 in being slightly in excess of the average. While, however, the rainfall of the calendar year and the seasons was close to the average, the distribution in time was very erratic. The year included the wettest January since 1877, and the wettest November and the driest December since before 1870. The distribution over the British Isles of the annual number of days with rain is dealt with in a separate article. A description is also given of some experiments on the shielding of rain gauges in windy localities. Copies of the publication, which is now issued by the authority of the Meteorological Committee of the Air Ministry, can be purchased from all branches of H.M. Stationery Office or through any bookseller, price 15s. net.

INSTITUTE OF FUEL.

THE autumn meeting of the Institute of Fuel will be held at the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2, on Wednesday and Thursday, November 23rd and 24th, 1927. The following programme has been arranged:—On the Wednesday morning, at 10.30 o'clock, there will be a general meeting, followed by the presidential address of Sir Alfred Mond. The following papers will then be presented in abstract and discussed:—(*a*) "National Electricity Supply—Better Utilisation of our Fuel Resources," by Sir Philip Dawson; and (*b*) "Operating Experience of Steam Production at 1300 lb. Pressure," by J. Anderson, of Milwaukee. In the afternoon, at 2.30 o'clock, the following papers will be presented in abstract by their authors and discussed:—(*c*) "Measurement of Steam Flow in Works Practice," by T. Nordenson and H. C. Armstrong; and (*d*) "Preheated Air for Boiler Furnaces," by P. H. N. Ulander. In the evening the annual dinner of the Institute will be held at the Wharncliffe Rooms, Great Central Hotel, Marylebone, London, N.W. 1.

On the Thursday morning, at 10 o'clock, the following papers will be presented in abstract by their authors and discussed:—(*e*) "The British Coking Industry and Some of its Products," by Robert Ray; (*f*) "Vertical Intermittent Chamber Ovens," by N. J. Bowater, Assoc. M. Inst. C.E.; (*g*) "The Chemical Study of Processes Involving the Carbonisation of Coal by Internal Heating," by Professor M. W. Travers, F.R.S. In the afternoon session, at 2.30 o'clock, the following papers will be presented in abstract by their authors and discussed:—(*h*) "Conversion of Coal into Oil by the Bergius Process," by J. Ivon Graham and D. G. Skinner; and (*i*) "Liquid Fuels, Other than Petroleum," by A. E. Dunstan, D.Sc., and H. G. Shatwell, D.Sc. A paper on "A Critical Study of the Determination of the Heats of Formation of Steam and of Carbon Dioxide," by Professor M. W. Travers, F.R.S., will be presented for record purposes, but not discussed.

CONSTANT-RADIUS LUFFING CRANE

THE SURREY ENGINEERING CO., LTD., LONDON, ENGINEERS

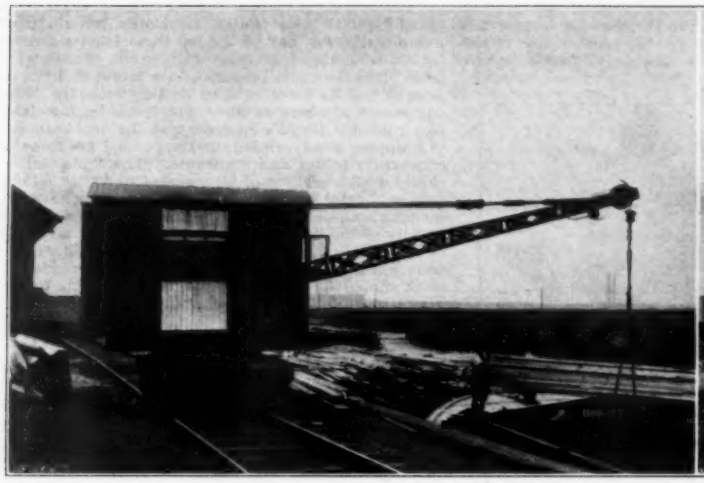


FIG. 1

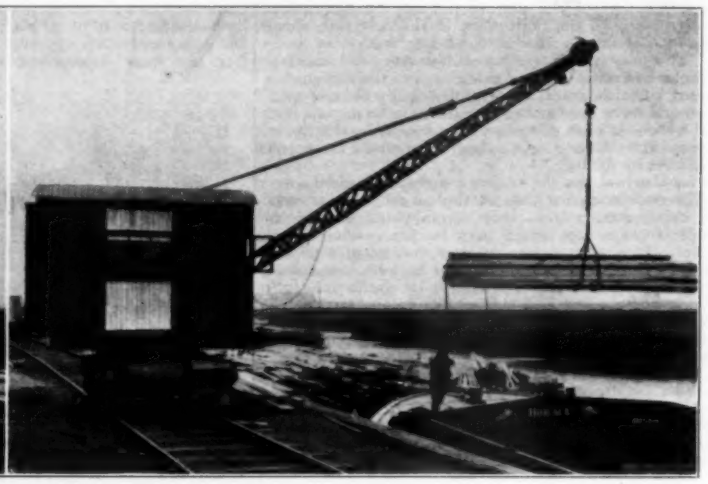


FIG. 2

A Constant Radius Luffing Crane.

In the issues of THE ENGINEER for August 26th and September 2nd, Mr. E. G. Fiegehen gave a comprehensive review of the various types of level-luffing jib cranes which are now built, and showed the progress which has recently been made in that particular type of crane. In the following article we describe a new type of luffing jib crane with a constant radius. It presents some interesting features of construction, and would seem to meet the special conditions which have to be met in handling goods in warehouses and wharves when it is desired to unload and to stack material at one handling.

The crane which we illustrate in the accompanying engravings, and which we recently inspected at work at Barking Creek, was being used at the wharf of Austins (East Ham and Ilford), Ltd., to unload timber from barges in the creek, and either stack the same in the yard, load on lorries, or stack under the comparatively low lean-to roof which is to be seen at the extreme left of Fig. 1.

The essential feature of the design which can be clearly seen from our illustrations, is the mounting of the jib pivot on a radial arm, which enables the jib to be lowered in a vertical line. Figs. 1 and 2 show the jib in its lowest and its highest positions. Details of the machinery arrangement of the crane are shown in drawing Fig. 3. The quay frontage on which the crane operates is about 100 yards long. At one end of the railway track is a water-tight junction box and switch plug which is connected to the 460-volt direct-current Barking supply system. The current is taken to the crane by a length of C.T.S. trailing cable, which is automatically wound-up and paid-out from the cable drum at the front of the carriage. The cable drum is belt driven from the crane axle, the belt being kept taut by a jockey pulley. The current passes by means of slipping contacts through water-tight connections to a series of slip rings arranged on the underneath side of the main pivot of the crane, and cables are taken from that point to the main circuit breaker and maximum and minimum cut-outs. They then pass to a four way distribution board supplying the reversible type drum controllers in the operator's cabin.

The lifting motor is coupled direct to a worm gear, on the driven shaft of which is keyed the hoisting drum. It has a designed output of 6 B.H.P. at 730 revolutions per minute, and hoists the load at 44ft. per minute. The crane is designed to lift loads up to 20 cwt., and was, we learn, tested at 27 cwt. with every satisfaction. The luffing gear is a duplicate of the hoisting mechanism, and the same size of motor is employed, the luffing speed being about 22ft. per minute. To slew the crane a 2 B.H.P. motor, running at 750 revolutions per minute, which gives 1¼ complete revolutions of the jib in one minute, is used. Travelling is effected by another 6 B.H.P. motor running at 730 revolutions per minute, which is coupled to the track wheels through a chain drive and bevel gearing. It gives a travelling speed of 112ft. per minute.

The crane, which was constructed by the Surrey Engineering Company, Ltd., of 66, Shoe-lane, London, E.C. 4, is of normal construction, with the exception of the radial arm motion, which gives the constant radius of the jib during luffing operations.

As will be seen in the drawing, Fig. 3, the four controllers are so grouped that they can be worked simultaneously, and we noted that the crane operations could be carried out faster than the rate at which the loads could be slung on the hook. The crane travels on a standard 4ft. 8½in. gauge trailing truck and has a jib radius of 25ft. When the jib is lowered—as shown in Fig. 1—it is only 11ft. above the quay, while in its highest position its height is 25ft. In order to control automatically the extreme limits of the jib movements, two special self-replacing limit-switches are fitted. A similar appliance is fixed at the head of the jib, and is operated by the ball above the crane hook. In addition to the particular use we have described, the crane can be designed as a self-contained runabout crane for discharging goods from trucks or barges with a fully raised jib, then while travelling, luffing to the lowest jib position to allow the crane with its load to pass through a warehouse door, after which the jib can again be raised to stack the goods. With the constant radius given by the arrangement we have described, a uniform factor of stability, it is claimed, is obtained, thus

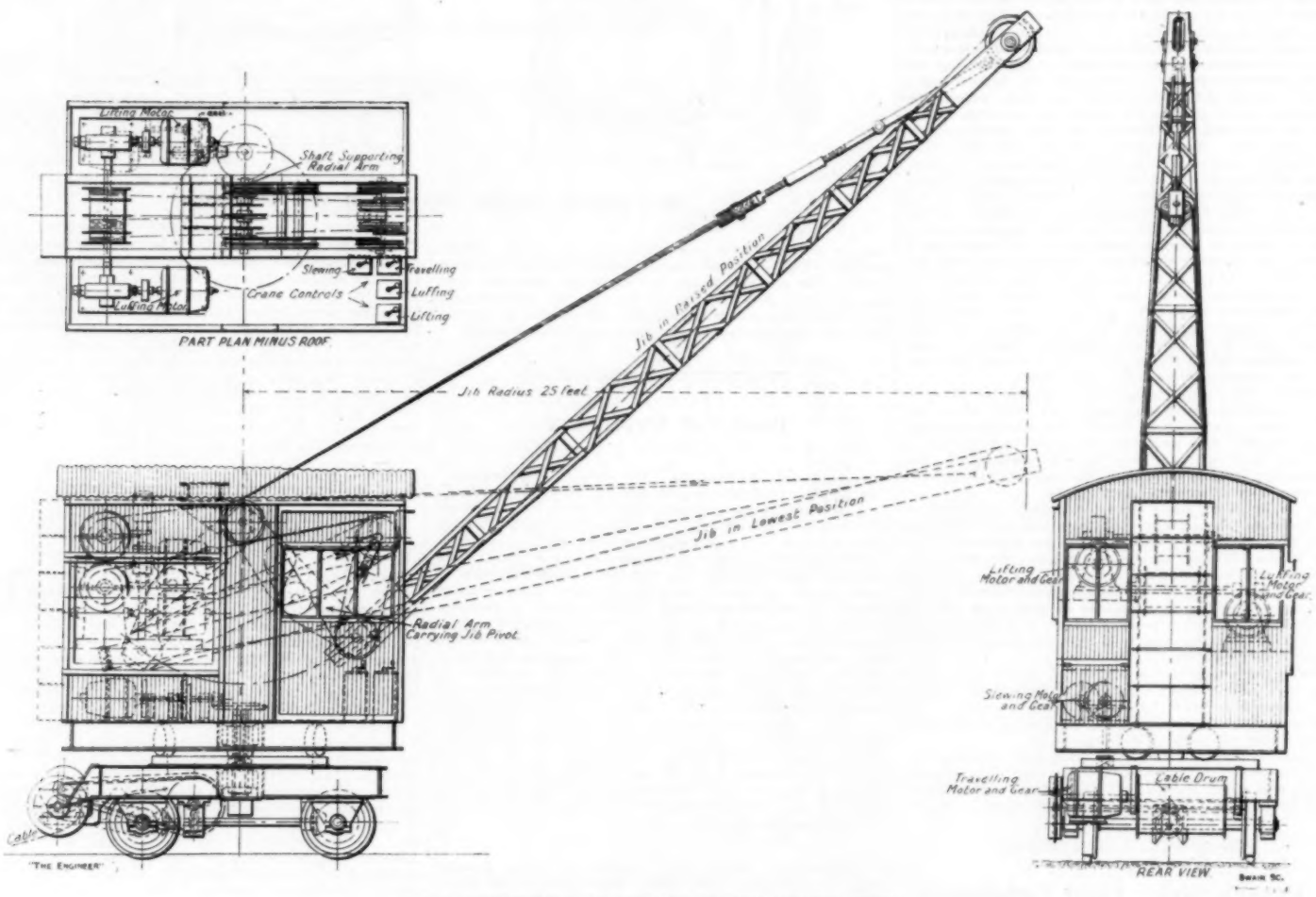


FIG. 3—ARRANGEMENT OF CONSTANT-RADIUS LUFFING CRANE

enabling the crane to be worked by unskilled attendants with safety.

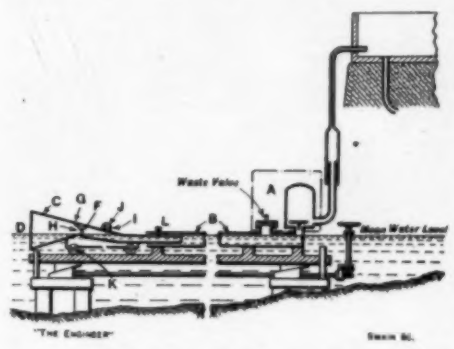
The crane we have described was constructed under the joint patents of Mr. Robert A. Smith, consulting engineer, of 14, Victoria-street, London, S.W. 1, and Mr. Thomas Meacock, of Southend, to whom we are indebted for the particulars upon which this description was based.

A Wave-Power Machine.

MANY schemes have been suggested for the commercial utilisation of wave power, that is to say, the resultant energy of water after it has been subject to the influence of continuous winds. The latest of them is advanced by Lieut.-Commander L. Smith, of Washington, D.C., and forms the subject of a descriptive article in *Mechanical Engineering*, the organ of the A.S.M.E. We summarise the description below.

Put briefly, the idea is to operate a hydraulic ram by the impulse of the waves, and to raise water into a high reservoir, in falling from which it could be used to generate power in turbines. The accompanying sketch shows the essential features of the plant.

On the seashore, transversely to the direction of the prevalent waves, there is installed a long "drive pipe," with a funnel-shaped mouth extending out into water so deep that the waves are unlikely to break. At the inshore end of this pipe there is a hydraulic ram delivering to a raised reservoir. The whole apparatus is so mounted that it can be raised and lowered with the tides, while the mouthpiece can be extended or retracted to suit the weather conditions. It will be noticed that the throat of the mouthpiece is so raised as to form a weir, which



SMITH WAVE-POWER MACHINE

ensures that the drive pipe is always full of water. There is also an air escape valve just inside the weir, which allows any entrapped air to escape, but closes upwards through the valve itself floating, when the pipe is full of water, so that the water is not wasted. At the crest of the weir there is also a flap valve in the main channel to prevent any reflux of water. The mechanism of the hydraulic ram needs no comment, as it is presumably of normal design.

It is obvious that the waves caught by the mouthpiece will gain velocity as they approach the throat, and will provide an impact on the column of water in the drive pipe, which should actuate the hydraulic ram at least once for every wave cycle, provided, of course, that the waves were sufficiently strong to overcome the various resistances, but the inventor goes further and suggests that in the case of long and high waves the ram may function several times during the period of one wave, while abnormal waves may result in the water "squirting" through the machine without the waste valve of the ram coming into action. In such cases, he says, the efficiency of the apparatus would be reduced.

The description given by the inventor includes a number of calculations, from which it may be deduced that every foot of wave frontage possesses, theoretically, from about 1 to 61 horse-power, when the normal depth of water is 30ft., according to the height of the wave as it ranges between 2ft. and 12ft. Working on these assumptions, and allowing efficiencies of 90 per cent. for the mouthpiece, 90 per cent. for the drive pipe, 80 per cent. for the hydraulic ram, and 94 per cent. for the "accumulated potential energy," Mr. Smith estimates that some 60 per cent. of the total kinetic energy of the waves may be accumulated in the storage reservoir, and that "a 4ft. wave in water 30ft. deep, a very moderate and usual condition, has 5·45 H.P. per foot of front, or 28,816 H.P. per mile."

No effort is made in the article from which we are quoting to estimate the capital costs of such a plant, but it would seem to us to be rather high for the amount of power in prospect.

THE SEVENOAKS RAILWAY ACCIDENT.—As briefly reported in the "Railway Matters" column of our last issue, the coroner's jury who have been inquiring into the thirteen deaths that resulted from the derailment of August 24th, at Sevenoaks, returned a verdict that the cause of the accident was not, in their opinion, disclosed by the evidence. They added a rider to the effect that they did not consider that the class of engine known as the "River" type was suitable for fast traffic on that section of the line—between Dunton Green and Sevenoaks—owing to its rolling tendencies. It is not our intention to discuss this judgment or any phase of the accident until the report of Colonel Sir John Pringle, who inquired into the facts on behalf of the Ministry of Transport, and whose views necessarily must have more weight than those of a coroner's jury, is before us. As, however, a situation has been created that, as far as our memory serves us, is without parallel, inasmuch as the verdict implies no liability on the part of the railway company. This should be read in conjunction with the report of Sir John Pringle's inquiry that appeared on page 308 of THE ENGINEER of September 10th. It ought also to be added that both the coroner and the jury thanked the Southern Railway officials for the frank and complete way in which they disclosed all the known facts.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

INDUSTRIALISTS in the Midlands and Staffordshire regret they are unable to take the same optimistic view of the trend of trade as that recently expressed by the Chancellor of the Exchequer and other highly placed persons. While many of them are inclined to the opinion that there is some ground for a more hopeful view of the industrial situation anything in the nature of "boom" conditions or even of industry being in full swing in the immediate future is considered, to say the least of it, premature. They are prepared to grant that of the many-sided engineering interests which have their centre in the Birmingham district, some are able to report an improvement, but they point out its spasmodic nature. The outstanding feature of Midland industry at the moment is, of course, the motor trade. Much good business has resulted from the two recent shows at Olympia, and the leading firms are working at considerable pressure. Producers of special steels are hoping for big orders from the motor-car factories. Report suggests that better things may be in store for makers of structural steel, but that remains to be substantiated. Even the electrical branch of the engineering industry, which is perhaps better placed than any other, is slack in many of its departments. Machine tool makers in several instances report an improvement, although slight, in the general engineering branch. The iron and steel trades, which, after all, are the industries on which all others depend, are in anything but a satisfactory position. The volume of business is nothing like sufficient to give reasonably good employment to productive resources. At to-day's meeting on the Birmingham Exchange it was reported there was no improvement in the general demand for iron or steel, the position remaining discouraging.

Raw Iron Prices.

Although many Midland smelters are clinging tenaciously to the 1s. advance in foundry pig iron prices gained at the beginning of the quarter, this week has witnessed considerable wavering on the part of other furnaces poorly placed for business. On 'Change to-day there were Derbyshire and Northamptonshire blastfurnacemen willing to shade quotations to the extent of 6d. per ton, Derbyshire No. 3 foundry being obtainable at £3 5s. 6d. and Northamptonshire at £3 0s. 6d. Those Derbyshire houses which last week were endeavouring to secure £3 7s. for their output are now prepared to do business at £3 6s. North Staffordshire makers quoted foundry iron £3 6s. Sales all round were confined to small lots for immediate consumption, forward buying being absent. The total tonnage, however, was better than in recent weeks. There is no difficulty in obtaining early deliveries of most grades of iron. Furnacemen whose trade connections lie chiefly in the Birmingham area say they are maintaining the balance between output and sales; there is no sign of nervousness lest the curtailment of production should result in stringency and consequent higher prices. Trade in forge pig remains inert. Hematite is in rather brisker demand, some sales of East Coast mixed numbers having been made at £4 10s. delivered Birmingham, or £3 14s. at furnaces. With continental raw iron prices tending upwards a rather better prospect seems to be opening for the British smelter, but he will need very much bigger turnover to make present selling prices remunerative.

Steel.

Steel business continues disappointing. Orders for structural material have fallen away further, steelmasters on 'Change in Birmingham to-day reporting that inquiries for this material are few and far between and small in character. Midland engineers are confident that a good deal of heavy business is pending, and when this is placed it will, they assert, go some way towards making up for present shortages. Steelworks in this district, though short of orders, are able to make about two-thirds time. Finished steel prices are unchanged. There is not much life in the semi-finished branches, either British or foreign. Continental prices for steel semis have a firmer tendency, but there is no urgency of demand from this side to assist it. English billets are quoted at £6 5s., and orders are improving somewhat. Foreign billets cost £5 5s. delivered in this district. Quotations for foreign steel are not so numerous, but recent lists offer joists at £4 10s. 6d., plates £6 1s. 6d., and steel bars £4 16s. 6d. Re-rollers in Staffordshire are well stocked with foreign billets, and are not buying much fresh material. Heavy steel scrap is dull at £3 delivered South Wales. There are fairly large stocks and prompt delivery can easily be obtained.

Finished Iron.

The Staffordshire finished iron trade is no more favourably placed than of late, orders for the most part being small and irregular. Mills producing best quality iron are securing sufficient orders to ensure fairly regular employment, but this is not the experience of works making Crown bars, or nut and bolt iron. Marked bars remain at £13, but there is still much disparity in the prices of unmarked bars of Crown quality. Staffordshire houses claim to be doing business at about £10 10s., but other firms are offering Crown iron at as low as £9 7s. 6d. Many of the Lancashire houses are prepared to do business at £9 15s., and some merchants claim even less. There is scarcely anything being done in common bars for nut and bolt and fencing work, the place of the home producers having been completely usurped by the Belgians, so that it is no longer a question of competition. The local quotation remains unchanged at £9. Belgian No. 3 iron is now offered at as low as £4 16s. 6d. f.o.b. Antwerp. There is a fair demand for wrought iron tube strip, values of which are maintained at £11 10s.

Galvanised Sheets.

In the galvanised sheet trade business is still quiet. Corrugated sheets of 24-gauge are quoted at from £13 10s. to £13 15s., or half a-crown below last week's minimum. The slackness is more noticeable than for months past, and some of the big mills are only able to run at half strength, while others are closed down.

New Birmingham Water Scheme.

Proposals involving an expenditure of £750,000 in connection with the Birmingham water supply are to be submitted to the City Council at its meeting next month. With the object of ensuring that the whole of the city shall be adequately supplied with water, the Birmingham Water Committee will recommend the expenditure of the above sum on the aqueduct from the Elan Valley, and also in improving the local distribution. Of the total sum of three-quarters of a million which it is proposed to raise, about £300,000 will be devoted to the extension of the aqueduct in order to increase its capacity and secure a further quantity of water for the city. An amount of £25,000 will be utilised for the strengthening of the existing mains on the aqueduct, and a sum of £60,000 for improving the supplies of Elan water in the Erdington district. The extension contemplated in the new scheme will yield, it is estimated, an additional supply of 4,000,000 gallons of water a day.

Coventry Water Supply.

An important scheme for extending the Coventry Corporation water undertaking, at a cost of over £300,000, is engaging the attention of the City Council. The scheme is to ensure an adequate supply of water for the extended city. The works include new wells at Watery Lane, Brownshill Green and Mount Nod, with pumping stations at the last two sites, and the following works in connection with the distribution system of the water undertaking:—In the low level zone a new service reservoir at Coundon with a capacity of 9,000,000 gallons; new and electrically-driven plant at Spon End and Whitley pumping stations; removal of the open tank from Spon End, and other works. In the middle level zone a new service reservoir at Meriden Ridge, with a capacity of 500,000 gallons; a new service reservoir at Corley, with a capacity of 10,000,000 gallons; a water tower near Earlsdon; distributing and other mains from Meriden Ridge to Corley; from Corley to the Earlsdon water tower, and in other positions. In the high level zone a water tower near Tile Hill; additional works at the existing reservoir at Corley, and various distributing and other mains. It will be necessary to obtain the sanction of Parliament before the greater part of the various works can be carried out, and matters have progressed sufficiently for the proposals to be incorporated in a Bill which is to be promoted by the Corporation in the next session of Parliament. Certain of the works, however, which include the new service reservoir at Coundon—capacity 9,000,000 gallons—and the delivery main for the supply of Badworth, will not need to be included in the application to Parliament.

South Staffordshire Miners' Wages.

The certificate of ascertainment presented to the quarterly meeting of the Joint District Board for the Coal Industry in South Staffordshire and East Worcestershire showed that the percentage payable was 131·58 of basis rates; therefore the minimum wage of 40 per cent. on basis rates will be paid during the months of November and December and January next. There is a deficiency of £10,237 to be made good in future ascertainments.

Cannock Chase Coal Slump.

The coal industry in the Cannock Chase and Hednesford area is poorly off for orders, and the cold snap which set in this week was very welcome as being conducive to an increase in domestic coal consumption. With one or two exceptions, all the pits in the district have been on three days a week, and the spectacle of thousands of miners walking about the streets in the winter season is a most unusual one.

Unemployment.

After falling for some weeks the totals of unemployment in the Midlands show a fairly large increase, although the bulk of the increase is accounted for by men who are on short-time or temporarily standing off work. The total unemployed for the week ended October 31st was 126,724, compared with 120,564 at the end of the previous week; included in the first total are 32,488 on short-time or off temporarily, this figure having risen from the previous week by 5371. Birmingham accounts for a large proportion of the increased numbers, other Black Country towns where the numbers have risen being Bilston, Dudley and Walsall. At Coventry more workers continue to be absorbed into the motor engineering industry, the unemployment figures having again fallen this week, viz., from 5251 to 4935.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Railway Electrification.

SIR JOSIAH STAMP, chairman of the London, Midland and Scottish Railway Company, was in Manchester on Tuesday of this week discussing British economic policy at a luncheon of the Economic League, but, if current reports are correct, he has taken advantage of his visit here to discuss a matter more directly concerned with the railway world. It is rumoured that the proposed electrification of the Cheshire Lines joint railway between Manchester and Altrincham, a distance of roughly 10 miles, is again under consideration. Sir Josiah spent part of Tuesday morning inspecting the line, and it is reported

that his visit is concerned with inquiries that are being made regarding the advisability of electrifying the system.

Non-ferrous Metals.

Apart from copper, there is weakness on balance in every section of the non-ferrous metal market compared with a week ago. Tin has been decidedly erratic in its movements, the lowest point of this year being touched at one period, followed by a pronounced rise, and a closing quotation for spot metal, which is nearly £1 10s. a ton below what it was at this time last week, although somewhat better than the worst during the period under review. At times there has been a fair amount of buying going on, but the present indications are that supplies of the metal are less scarce than certain "bullish" elements in the market have been disposed to assert recently. There has been a good deal more activity in the copper market of late, although in view of the reduced stocks, both in this country and in the United States, which have encouraged rumours of a prospective shortage much of the buying has been of a speculative character. At the same time, however, greater interest in the metal has been shown by the copper-using industries, though the bulk of the current buying relates to near delivery dates. Values in this section of the market have acquired additional firmness, thus continuing the improvement which had gone on without interruption during the previous five or six weeks. Spelter has relapsed sharply on poor trade buying from all directions and plentiful supplies, although at their present levels values are unlikely to go very much lower. Lead has more than lost the advance reported last week, and prices are now back to where they were a fortnight ago. Supplies of lead are more than sufficient to meet the moderate demand for the metal.

Iron.

The belief is growing on the iron market here, in view of the quiet conditions that are now prevailing, that renewed buying interest on any appreciable scale is unlikely to be experienced before the turn of the year. This week there have been one or two contract bookings reported, but they have been for comparatively limited quantities, and for not very far ahead, the bulk of what has been really a comparatively small aggregate business being for odd lots for early delivery. Practically all sellers —Midland producers as well as the remainder—agree that this represents current conditions, but the philosophic view of the former, in particular, that "We cannot expect to fill users' requirements twice over," is eloquent of the position. For the time being, what most of them are concerned about principally is effecting deliveries against specifications which continue to flow fairly freely. Prices keep steady in all sections of the market, and there is no sign of values giving way anywhere. Staffordshire brands of No. 3 foundry iron are currently quoted for delivery in the Manchester area at about 73s. 9d. per ton, with Derbyshire at 73s. 6d. to 74s., according to quantity, Middlesbrough at 80s. 8d., Scottish at 89s., and West Coast hematite at 86s. Lancashire makers of bar iron are feeling keenly the effects of competition from continental producers who are prepared to sell for delivery in the Lancashire area at not much more than half the prices that are being asked for the locally made material. The demand for the latter is on a very moderate scale, but there has been no further change in quotations. Lancashire Crown quality bars being offered at £10 per ton and seconds at £9 10s.

Steel.

Buying of steel by consumers in this area continues on the same lines as before, the fundamental feature of the market being that little or no contracting forward is going on. As old contracts expire—and they are fast coming to an end—users are regulating their purchases to their early requirements, rarely going more than a few weeks ahead. This they are enabled to do by the fact that early deliveries from the rolling mills are obtainable without much difficulty, and they are encouraged to pursue this policy by reason of a growing belief among buyers in this market that a reduction in the minimum prices for certain varieties of British steel is not improbable before long. Ship and tank plates and joists and sections are unchanged in price at £8 7s. 6d. and £7 12s. 6d. per ton, respectively, but a somewhat easier tendency is to be observed in the case of steel bars. Small re-rolled bars are quoted down to £7 12s. 6d. per ton, and even this figure is being shaded in some instances. For basic bars prices are in the neighbourhood of £8 10s. Boiler plates are also rather a weak section of the steel market, offers of these varying from £10 10s. to £10 15s. per ton. There has been a little more activity in imported finished steels, but inquiry for semi-finished qualities is on a moderate scale. For delivery to buyers' works in Lancashire, for cash against shipping documents, continental sheet bars are quoted at £5 to £5 2s. 6d., billets at £4 19s. to £5, angles at £5 16s. 6d., wire rods at £6 8s. 6d., joists and sections at £5 12s. 6d., steel bars at £5 16s. 6d., Thomas plates at £7 2s. 6d., and Siemens plates at about £7 12s. 6d. Galvanised sheets are arousing little buying interest, particularly for shipment, and the 24-gauge materials are easy at £13 10s. to £13 15s. per ton f.o.b.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron market for the North-Western district is not showing the signs that were hoped for, and at present there is just a tendency for business to lag. The little spurt made a few weeks ago by customers when prices eased seems to be over. It is hoped that this quietness is only temporary, but it is impossible to say which way the trade will turn. Makers have not accumulated heavy stocks, owing to the fact that two of the big works steel departments have been taking a good quantity of iron. Another factor in keeping down stocks at the moment is the despatch of pig iron to market, and there has also been a dispatch of pig iron for Kobe. The outlook is not very assuring, and customers are only ordering iron for immediate requirements. In special classes of iron there is a moderate demand for low-phosphorus qualities. The iron ore trade is only moderate, and will continue to remain in that condition until more furnaces are in blast. When that will be no one knows. The steel departments keep fairly well employed, and orders are held which will keep them going for some time.

SHEFFIELD.

(From our own Correspondent.)

Prospects in the Steel Trade.

THERE is no improvement to report in the basic steel trade of Sheffield, nor are any signs apparent of the buying movement which has been so long looked for. A good many of the open-hearth furnaces of the district are idle. Three local firms are to share in contracts for steel rails which the London and North-Eastern Railway Company has given out, in connection with its renewals programme for 1928, and the work will be very welcome. The total tonnage of rails ordered by the company is 41,500. The work is divided among ten firms, those in this district being Cammell Laird and Co., Ltd., of Sheffield and Penistone; Steel, Peech and Tozer, Ltd., of Rotherham; and S. Fox and Co., Ltd., of Stocksbridge. The quantity of railway work being given out to the axle, tire and spring plants is still on a small scale.

The Manufacturing Side.

While the trade in ordinary qualities of steel is poor, and has to contend against severe competition, the makers of steel and steel products of a special character are more favourably situated. In these branches competition is less keen, and in some cases does not exist, so that the trade is of a fairly remunerative character. There is a moderately good demand for heavy mining and road plant, a considerable proportion of which is for overseas. The motor industry is a good customer for various Sheffield specialities. On the whole, on the lighter side of the steel trade things appear to be a little better. The change is not very marked, but it is in the right direction, and a fair amount of optimism is felt as to the prospects of improved conditions during the winter months.

Vickers and Armstrongs.

For some time past there have been rumours of an amalgamation, to a greater or less extent, between the great firms of Vickers Ltd. and Armstrong, Whitworth and Co., Ltd. At the last annual meeting of Vickers, the chairman, Sir Herbert Lawrence, stated that any direct amalgamation had not been contemplated and would not be practicable, but that in certain branches of their respective businesses a working arrangement would be possible in order to facilitate more economical production. It is now announced that the two companies have signed a provisional agreement for the amalgamation of certain of their important works and businesses engaged principally in naval shipbuilding and the manufacture of heavy and special steel and armaments. A new separate company is to be formed, and will take over the businesses in the New Year. The remarks of Sir Herbert Lawrence on rationalisation of industry, which I quoted last week, may be read with interest in the light of the present announcement.

Cutlery and Plate.

The cutlery and plate trades are enjoying the busiest Christmas season that they have had for many years. Some houses are actually finding it difficult to get their orders out in time for the Christmas shopping. Girl labour, for buffing silver and plate, is scarce. The seasonal demand from the Dominions has been good, while the call from home distributors, for both cutlery and plate, is on a considerably larger scale than last year. The pressure on the factories is not uniformly heavy, however, and some of them report that their order books are rather meagre. Not many large canteens and cabinets of cutlery and plate are being sold, but there is a good demand for cases of the smaller sizes.

Bridge Improvements.

An important improvement in the facilities for crossing the Trent will be inaugurated on the 17th inst., when the Prince of Wales will officially open the new bridge at Gunthorpe, in Nottinghamshire. The bridge is built of concrete, and is 451ft. long, consisting of a centre span of 125ft., two side spans of 101ft. 6in. each, and two flood openings. The width between parapets is 40ft. The bridge will take the place of the existing Gunthorpe toll bridge, an iron structure a quarter of a mile away, which was erected upwards of half a century ago. This was found to be unable to withstand present-day traffic conditions, and the Nottinghamshire County Council obtained an Act of Parliament authorising its purchase with its toll rights. The new bridge is approached on either side by concrete roads with a total length of one and a-quarter miles. Not only is this crossing of the Trent to be freed, but another, at Gainsborough, has already been freed to a great extent, and is on its way to become free altogether. The bridge over the river in that town, which was built 140 years ago at a cost of some £12,000, has been purchased from the company which owned it for £130,000. The original value of the shares in the company was £66 each, and £1000 each has been paid for them. The bridge has now become the joint property of the Gainsborough Urban Council, the Notts. and Lindsey County Councils. These bodies have between them found 25 per cent. of the purchase price; the Ministry of Transport has provided 50 per cent. out of the Road Fund; and the remaining 25 per cent. is to be obtained by charging reduced tolls for a period estimated at five years. Last week Sir Henry Maybury formally declared the bridge free to pedestrians and pedal cyclists, with a certain reduction to motorists, amounting to about 25 per cent.

A Sheffield Trade Inquiry.

The recently formed Junior Chamber of Commerce in Sheffield is setting about its work with youthful ardour. It proposes to endeavour immediately to achieve some definite object which will stimulate interest and give every member an opportunity of taking part in the work. The organising committee considers that there could be no better subject on which to deliberate than that of Sheffield trade, and the reasons why it is in a state of depression. It is therefore proposed to embark upon an exhaustive inquiry, which will have as its object the issuing of a report on present conditions of trade, together with recommendations as to how it might be improved. All the members will be absorbed on one or other of the various committees which will be set up to consider such questions as costs of production, finance and taxation, costs of labour, transportation, and selling organisation.

Municipal Matters.

The Electricity and Tramways Committee of Lincoln City Council recently visited Chesterfield, and inspected the garage, workshops and offices erected by that town for the accommodation of a hundred vehicles, including trackless trams. Arising out of the visit, the Committee made a recommendation, which the Council has adopted, instructing the Surveyor to prepare and submit for consideration proposals for the erection of a garage, workshops and offices at a cost, excluding land, not exceeding £20,000. The Council has also decided to apply to the Ministry of Transport for sanction to borrow £25,000 for the purchase of not exceeding fifteen omnibuses for service when the tramway is discontinued.

A Rotary Plough.

Interesting new principles are embodied in a rotary plough which John Fowler and Co., Ltd., of Leeds, has just completed for use on a Cuban sugar plantation. An experimental machine of the type has been working for two years. The full-size plough is of large dimensions, weighing more than 20 tons, and having an engine capacity up to 220 H.P. The revolving plough shares are operated upon a vertical shaft instead of a horizontal one, the object being to reduce the risk of mixing the subsoil with the top layer, while at the same time the subsoil is not pressed down hard. A width of 10ft. is ploughed at the rate of from a half to three-quarters of a mile per hour. In a demonstration near Leeds, the plough broke up the ground to a depth of 19in.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal Miners' Wages Agreement.

THERE is so much depression in the Durham coal trade just now that it is hardly conceivable that the miners would make the situation worse by taking up anything but a conciliatory attitude with regard to the proposals which the owners have put forward for the amendment of the agreement between them. Nevertheless, it is very gratifying to learn that the discussions which took place this week between the parties were of a very amicable character. A proposal by the owners is that the clause in the Northumberland county wages agreement regarding arbitration on percentages on basis rates should be embodied in the Durham agreement. Many pits in the county are closed owing to the long depression which followed the national stoppage last year, and the economic condition of those in operation is such that the costs are much heavier than the proceeds from the coal in the open market. This month the joint report of the owners' and the men's accountants showed that the wages would be only 42·07 per cent. on basis rates but for the minimum of 89 per cent. now operating. The Durham wages agreement is dated November 30th, 1926, and at the end of one year it may be terminated by one month's notice on either side. The agreement is more likely to be amended, and that may be done as suggested by the owners by the incorporation of a clause in the Durham agreement from the Northumberland agreement. At all events negotiations are proceeding on satisfactory lines, and there is a general belief that terms will be agreed upon which will permit the continuance of the efforts which are being made to resuscitate the trade of the county.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade continues to improve, although the process is a slow one. Stocks are still being drawn upon in order to meet requirements. Home consumers continue to express dissatisfaction at having to pay 2s. 6d. more for their supplies than is charged to customers in Scotland and on the Continent, but makers appear determined to adhere to their fixed quotations, and are aided, so far as home prices are concerned, by the firming up of export quotations for foreign iron. Foreign iron delivered in this district is now very little cheaper than Cleveland qualities, but it is still successfully competing for the Scottish trade. Founders here are buying local products rather more freely, and sales to home consumers at a distance are on an improved scale, while occasional parcels are disposed of for shipment overseas. Imports of continental iron against running contracts continue fairly heavy. Quotations for Cleveland iron are firm, No. 1 quality being 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s. for home use. Export prices to Scotland and to destinations overseas are 2s. 6d. below the foregoing.

Hematite Pig Iron.

Demand for East Coast hematite pig iron is steadily expanding, but producers are still cutting prices to secure orders, and quotations are unsteady. Market rates are based on round about 72s. for mixed numbers, though customers claim to be able to make purchases on lower terms, and, on the other hand, some producers report transactions on a higher scale.

Ironmaking Materials.

Business in the foreign ore trade is confined to sales of odd cargoes, but merchants are taking a firm stand,

and hold that values are more likely to stiffen than otherwise. Best Rubio ore remains at 21s. per ton c.i.f. Tees. Makers of Durham blast-furnace coke are less inclined to grant price concessions, but ironmasters are only buying sparingly. Good medium qualities are on sale at 18s. per ton delivered at North-East Coast works.

Manufactured Iron and Steel.

A fair amount of activity obtains in the manufactured iron and steel trade, the exception being sheets. After a long spell of pressure the demand for this line has eased off somewhat. Finished steel is rather more sought after, though mostly for early delivery, buyers inclining to the belief that values may ease in the near future.

Iron and Steel Imports.

A striking feature of the statistics of imports of iron and steel to the river Tees during October is the fact that they showed a reduction of 13,296 tons as compared with September. The total for October was 28,447 tons. Semi-finished steel showed an increased importation of approximately 6000 tons, but pig iron declined from 21,000 tons to 2500 tons. Returns for the year, however, showed a further startling increase in the importation of Teesside's staple products. During the period November–October, 1913-14, only 56,564 tons of pig iron and crude and finished steel came into the district. In 1925-26 the total was 254,612 tons. During the past twelve months no less than 383,220 tons were imported. Pig iron brought in during the year totalled 105,566 tons, as compared with 81,061 tons in the corresponding period of 1925-26, and 1427 tons in 1913-14. The imports of crude sheet bars, billets, blooms, slabs, &c., reached 221,719 tons, as against 141,943 tons in 1925-26, and 33,655 tons in the pre-war period, while 55,935 tons of plates, bars, angles, joists, &c., were imported, as compared with 31,608 tons and 19,482 tons respectively.

The Coal Trade.

The Northern coal trade generally shows a quiet tendency. For immediate shipments, the majority of colliery owners are well booked and supplied with tonnage, but for the latter part of the month and for next month buyers decline to operate at the prices recently asked, and transactions are therefore of a limited character. The outlook, however, is regarded as fairly encouraging. The good feeling being shown between the Durham coal owners and the miners' representatives on the subject of the county agreement is regarded as very satisfactory, as there is less chance of any disturbing element creeping in when big contracts are under discussion. The possibilities of interruption in production are regarded as very remote, and, on the other hand, it is very probable that certain amendments will be made to the agreement, and that next year may be brighter for the industry than this year has been. Northumberland steam coal collieries have fairly good order books, and all prices are very steady. Best sorts are quoted at 13s. 6d. to 14s., and seconds at 13s. to 13s. 3d. There is a sustained market for steam smalls at 10s. Gas coals are well placed for all this month at undisturbed figures, and coking coals, though not quite so brisk as they have been, are selling fairly actively and command recent prices. The gas coke trade is brisk and supplies scarce for early deliveries at 24s. to 24s. 6d., but there is a disposition to hold off forward in the hope of lower prices, but makers take a cheerful view of the situation for all periods to the turn of the year. Manufacturing cokes are quiet, but steady in price, as production is kept to actual requirements. Good makes offer at 17s. 6d. to 18s. 6d., special qualities 24s. to 26s., beehive coke 25s. to 30s.

SCOTLAND.

(From our own Correspondent.)

Steel.

The market for steel has not undergone any change. Heavy steel is especially quiet, and practically all works still in operation are in need of specifications. Considerable quantities of foreign steel are being utilised in this district. Heavy steel sheets are now in demand, and the lighter gauges, though meeting with a fair turnover, are not so well placed as makers anticipated. Prices are unchanged.

Iron.

Producers of iron continue to have a lean time, for which foreign competition is partly to blame. Bar iron and steel re-rolling plants are poorly employed, and inquiries in the market do not promise an early improvement. Bar iron is unchanged in price, while re-rolled steel bars are quoted £7 15s. per ton for home and £7 2s. 6d. per ton for export delivery. Pig iron is dull and only the fact that prices are now barely remunerative prevents a further drop in quotations.

Exports and Imports.

Imports of iron ore totalled 18,000 tons last week, while 1500 tons of pig iron and 1600 tons of manufactured iron were discharged within the same period. Exports of iron and steel only totalled 2000 tons.

Coal.

Certain qualities of Scottish coal are in a better position at present, owing to recent foreign demands which allowed stocks to be worked off. Lanarkshire splints and ells, Lothians best steams, Fifeshire first-class steams, and Fifeshire third-class steams are all firm, and well booked for a week or two ahead. This foreign demand has dropped off again, however. Washed treble and double nuts are firm in all districts. Aggregate shipments amounted to 265,942 tons, against 249,444 tons in the preceding week and 259,565 tons in the same week in 1925. Home demands for all purposes are far below normal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Steam Coal Trade.

The general complaint in coal trade circles is the shortage of orders for prompt loading, and certainly the conditions are altogether very quiet and are causing a considerable amount of anxiety. Yet the loading position this week is no worse than last, and is really much better than what had been experienced earlier, inasmuch as the total of idle berths was on Monday, twenty-seven, whereas a fortnight ago the number ran to forty-seven. Shipments last week were maintained, as the total was over 396,000 tons, which was about 2000 tons more than in the preceding week. This, of course, is not a satisfactory level, as it is considerably short of what is required to clear stocks and to put any stiffening into the market. While there is very little fresh business about for early loading, it is encouraging to find inquiries on the market for supplies ahead. The Admiralty, in addition to its recent inquiry for coals over next year, has now asked for tenders for supplies for the home depôts, including steam and smithy coals, &c., which aggregate over 100,000 tons. The Greek State Railways have bought one cargo of steam coals for delivery at Piræus, and prices have gone in for another one for delivery at Salonika, the cargo in each case being about 5000 tons. Another inquiry is for a cargo of 5000 tons for the Palestine Railways, while the Syrian Railways are open for prices for 18,000 tons of patent fuel and 7000 tons of steam coals for delivery during the months of March, April, June and October next. The Algerian State Railways have asked for prices for 150,000 tons of patent fuel for delivery over 1928, and doubtlessly big efforts will be made to secure this order from our continental competitors. Another inquiry is from the Peloponnese Railways for the supply of 27,000 to 30,000 tons of patent fuel to be shipped in five cargoes to Piræus, Patras and Calamata between now and the end of June. Prices have to be in by the 11th inst., and there is no doubt that German manufacturers will make a fight for the order. It will be seen that inquiries are coming in, but apart from these there does not appear to be much disposition on the part of big exporters here or importers abroad to operate over 1928.

Later.

Colliery undertakings have received intimation from the British Admiralty regarding their purchases of supplies of coal over 1928. The aggregate quantity contracted for is difficult to estimate, but it is understood to be in the neighbourhood of 140,000 tons to 150,000 tons. Prices have not been divulged, but from all accounts they are considered satisfactory in the circumstances.

Foreign Barriers and Minimum Prices.

The official announcement was made at the end of last week by the Belgian Consul at Cardiff that he had received from the Belgian Government a statement that no measures are in contemplation by the Belgian Government restricting the imports by licence of foreign coal into Belgium. This is very satisfactory, especially as it was known that a committee had been considering for some time what steps might be taken with a view to protecting the Belgian mining industry. Hopes are entertained that before very long France will withdraw the licence system in force in that country respecting the importation of coal. No little amount of interest has been created by the announcement made at Geneva by the head of the French delegation to the Conference for the Abolition of Restrictions on International Trade that it was the intention of the French Government to remove the ban on the importation of foreign coal and coke. There appears to be, however, a question of negotiations between France and Germany being satisfactorily concluded on this subject, so that until more information is forthcoming, it is unwise to be too optimistic. The local Coal Exporters' Federation has wired to Paris for more information, and this is eagerly awaited. Reference was made last week to the proposed scheme of the coalowners for stabilising the market. The report of the sub-committee which has been before the Commercial Committee and has now been circulated to the individual members of the South Wales Coalowners' Association, will, it is understood, be made public next week. It is rumoured, however, that the scheme involves the allocation of outputs based on outputs over a preceding period; the levy of 3d. per ton of coal produced as payment into a common fund, out of which collieries which produce less than their allocated quantities or which have been idle will be compensated; the imposition of a penalty said to be near 2s. per ton in cases where coals are sold below minimum scheduled prices; and the grouping of coals under a scale of minimum prices. These details are being freely discussed in coal trade circles, but whether they are those embodied in the scheme is not confirmed. Meantime there is a good deal of scepticism as to whether such a scheme can be made operative with any success.

Tin-plate and Steel Trade Wages.

A meeting of the workmen's side of the Tin-plate Joint Industrial Council on Saturday of last week decided to accept the conditions laid down by the employers in connection with their offer to renew the payment of the *ex gratia* bonus, this being that no new claims should be submitted to them in the interval. At a meeting of the Joint Standing Committee of the South Wales Siemens Steel Industry at Swansea on Monday a number of claims were considered, chief among them being that third hands at acid furnaces should be employed and paid by the firms, and that the sliding scale should be arrested at 20 per cent. instead of 6¼ per cent. as at present, to apply to men with base rates from 60s. downwards per normal week. It was eventually decided that the time was inopportune for acceding to the first claim, and as regarded the claim on behalf of the lower-paid men the employers felt that it could not be met owing to the depressed state of the trade, but they undertook that as far as the lower-paid men were concerned, these should have the drop of 5 per cent. in the sliding scale made good by a similar percentage being added to their existing *ex gratia* payments, so that they would receive a total of 50 per cent. on their base rates, which would give the labouring class £2 5s. per week.

Craftsmen's Demands.

The Executive Council of the South Wales and Monmouthshire Enginemen, Boilermen and Craftsmen's Association at a meeting held at Cardiff at the end of last week decided to make an application for an increase of 2s. per day on the standard rates to all members of the Association, and to make an effort to secure an improvement in the conditions of employment of men working overtime and at week-ends.

Trimmers' Hours.

With regard to the proposal of the coal trimmers that there should be a conference with the interested parties relative to altering the present system of working at the docks and bringing in the system of two continuous shifts, the directors of the South Wales Coal Exporters' Association, who held a meeting at the end of last week, expressed the opinion that the broken shift as worked now has been a considerable advantage to all sections of the trade, and their view is that a reversion to the former system would be disastrous, and should therefore be strenuously resisted.

Current Business.

The market has continued in a featureless condition, and nominally, at any rate, prices have undergone no alteration. Sized coals remain the steadiest section and command relatively good prices, but supplies of all descriptions of large and many qualities of smalls are excessive, with the result that the tone is easy. Coke and patent fuel are quiet markets, although one or two of the patent fuel manufacturers are rather better situated for prompt orders. The demand for pitwood is restricted, and prices remain about 27s. 6d. to 28s.

CONTRACTS.

The British Thomson-Houston Company, Ltd., has obtained a twelve months' contract from the Great Western Railway for the supply of Mazda gas-filled lamps.

British Brown-Boveri, Ltd., informs us, following on the order which its associated company, Brown, Boveri and Co., of Baden, Switzerland, had received some months ago for two trial express locomotives of the 2C–C2 class to operate at 1500 volts direct current, for the Spanish Northern Railway, information is now to hand that that order has been increased to twelve locomotives, all to be of the same type.

Royal Institution.—A general meeting of the members of the Royal Institution was held on Monday afternoon (November 7th), Sir Arthur Keith, treasurer and Vice-President, in the chair. The secretary reported that the Institution had received a legacy from the late Sir W. Pulpson Beale, M.R.I. The deaths of Lord Iveagh, M.R.I., Professor Mittag-Leffler, and of Professor Arrhenius, Hon. M.R.I., were announced and resolutions of condolence with the families were passed. Mr. Bright, Mr. H. Gill, Mr. A. H. Jenkin, Mrs. A. Patrick, Mr. E. B. Robertson, and Mr. M. Ruffer were elected members.

Prize Competition for the Best Paper on Goodwill in Industry.—The Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen invites papers on "Goodwill in Industry," for which it offers a prize of one hundred guineas. The subject is to be treated in a practical way as distinct from a purely theoretical standpoint, either by describing schemes and methods in actual operation, or by making definite proposals. The Committee appointed by the Association proposes to submit the papers to an impartial tribunal consisting of representatives of the three partners in industry for adjudication and award of the prize, to whichever they consider to be the best paper, which will be read at a meeting and become the property of the Association. Further particulars may be obtained on application to the secretary, Goodwill Committee, Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen, 1019, Sauchiehall-street, Glasgow, C. 3.

The Institute of Indexing.—We are informed by Mr. W. R. Douglas Shaw that that he is organising an Institute of Indexing to facilitate the advancement of knowledge in all fields of endeavour by promoting and extending public interest in the co-ordination of information through the medium of efficiently indexed books, periodicals, and other literary works and papers. To maintain a register of qualified indexers of all nationalities and in all branches of knowledge, and to place such register at the disposal of authors, editors, publishers, printers, and others responsible for the creation of literary works of all kinds. To give advice and assistance to members of the public requiring information, and to foster the publication of comprehensive indexes of the already-published works of celebrated authors. Mr. Douglas Shaw will be remembered by many of our readers as the compiler and editor of the great index to the "Transactions" of the First World Power Conference, a volume of 590 pages and 40,000 references. His address is Beaufort, Mornington-road, Chingford.

Engineering Salesmanship.—Mr. Robert Lowe, speaking at a meeting of the Junior Institution of Engineers, on Friday, November 4th, on the subject of "Engineering Salesmanship," made some valuable remarks concerning the status and function of commercial engineers. He said that a commercial engineer was born and not made, and that any man born to be a commercial engineer would always find his way into that profession. The qualities which made a salesman were many, and some of them were peculiar. The engineering salesman had to be engineer and seller too; he had to know his own goods, his competitors' goods, and his customers' requirements. He had to have confidence in his firm, and he had to stand up for it, and yet be quick to recognise a buyer's just complaints. He had to meet and mix with men of high standing and education, and not be out of place. He had (more rarely) to be the whipping boy for the customer who has been let down, and on those occasions he had to restrain his inward feelings. Mr. Lowe gave many episodes from his own experiences to illustrate the spirit in which a commercial engineer should set about his job. Some of his maxims for intending salesmen were:—"Take up commercial engineering before you marry, and never get married. It is a whole time job." "Never apologise for calling on a buyer, unless you are late." "Never run down your competitors' goods. You may one day have to sell them." "Always let a customer use a strong word first." These phrases go some way to indicate the attractiveness of manner in which Mr. Lowe can talk on this subject, in which he is so well versed.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/–
(1) Spanish	18/6 to 21/–
(1) N. African	18/6 to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	21/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 16 0	—
No. 1 Foundry	3 17 6	—
No. 3 Foundry	3 12 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 12 0	3 12 0
No. 1	3 12 6	3 12 6
Cleveland—		
No. 1	3 10 0	3 7 6
Silicious Iron	3 10 0	3 7 6
No. 3 G.M.B.	3 7 6	3 5 0
No. 4 Foundry	3 6 6	3 4 0
No. 4 Forge	3 6 0	3 3 6
Mottled	3 5 6	3 3 0
White	3 5 6	3 3 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 6 0	—
(3) Northampton—		
Foundry No. 3	3 0 6 to 3 1 0	
Forge	2 15 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 6 to 3 6 0	
Forge	3 0 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 4 0 to 3 5 0	
No. 4 Forge	3 2 6	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 6 6 (a)	—
	4 9 6 (b)	—
	4 13 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 15 0	10 10 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 15 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Lancs.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	12 10 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	12 5 0	—
Hoops	12 10 0	—
Midlands—		
Crown Bars	9 12 6 to 10 0 0	
Marked Bars (Staffs.)	13 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	
Gas Tube Strip	11 10 0	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¾in. and up	8 2 6	7 12 6
Sections	7 12 6	7 2 6
Steel Sheets, ¼in.	8 15 0 to 8 17 6	8 15 0
Sheets (Gal. Cor. 24 B.G.)	14 5 0	£13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 2 6	—
Angles	7 12 6	—
Boiler Plates	12 10 0	—
Joists	7 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	
Billets	7 10 0 to 10 0 0	
Manchester—		
Bars (Round)	8 10 0	—
,, (Small Round)	7 12 6	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 7 6	—
,, (Lancs. Boiler)	10 15 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 12 6 to 8 2 6	
Intermediate Basic	7 10 0	—
Soft Basic	7 0 0	—
Hoops	10 0 0 to 10 10 0	
Soft Wire Rods	9 5 0	—
Midlands—		
Small Rolled Bars	7 12 6 to 8 0 0	
Billets and Sheet Bars	6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	13 10 0 to 14 0 0	
Angles	7 12 6	—
Joists	7 12 6	—
Tees	8 12 6	—
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	17/6 to 17/9
Block Tin (cash)	258 5 0
,, (three months)	252 0 0
Copper (cash)	58 15 0
,, (three months)	58 12 6
Spanish Lead (cash)	20 2 6
,, (three months)	20 12 6
Spelter (cash)	25 12 6
,, (three months)	25 7 6
Manchester—	
Copper, Best Selected Ingots	64 0 0
,, Electrolytic	64 2 6
,, Strong Sheets	88 0 0
,, Tubes (Basis Price), lb.	0 1 0½
Brass Tubes (Basis Price), lb.	0 0 11½
,, Condenser, lb.	0 1 1½
Lead, English	22 0 0
,, Foreign	21 2 6
Spelter	25 17 6
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton	Per Unit.
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 17 6	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 10 0	6/6
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£36 0 0	11/6
,, ,, ,, 1 p.c. carbon	£41 10 0	15/–
,, ,, ,, 0·70 p.c. carbon	£53 0 0	17/6
,, ,, ,, carbon free	1/4 per lb.	
Metallic Chromium	3/– per lb.	
Ferro Manganese (per ton)	£12 0 0 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– per unit	
,, ,, 75 p.c.	£20 5 0 scale 6/– per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/– per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Ferro-Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

		Export.
Lanarkshire—		
(f.o.b. Glasgow)—Steam		13/3
,, ,, Ell		14/–
,, ,, Splint		15/– to 16/6
,, ,, Trebles		14/9
,, ,, Doubles		14/–
,, ,, Singles		11/9
Ayrshire—		
(f.o.b. Ports)—Steam		13/6
,, ,, Jewel		15/6
,, ,, Trebles		14/6 to 15/–
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		12/– to 13/–
Screened Navigation		18/–
Trebles		15/– to 16/–
Doubles		14/– to 14/3
Singles		11/3
Lothians—		
(f.o.b. Leith)—Best Steam		12/9 to 13/–
Secondary Steam		12/– to 12/3
Trebles		14/6 to 15/6
Doubles		14/– to 14/3
Singles		11/3

ENGLAND.

(8) N.W. Coast—	
Steams	24/– to 25/–
Household	40/– to 56/–
Coke	22/6 to 23/6
Northumberland—	
Best Steams	14/–
Second Steams	13/– to 13/3
Steam Smalls	9/– to 10/–
Unscreened	13/– to 13/6
Household	21/– to 27/–
Durham—	
Best Gas	15/9 to 16/–
Second	13/6 to 14/–
Household	21/– to 27/–
Foundry Coke	19/– to 26/–

Sheffield—	Inland.	
Best Hand-picked Branch	28/– to 30/6	—
Best Sleected House Coal	22/6 to 23/–	—
Screened House Coal	19/– to 20/–	—
,, ,, Nuts	16/– to 17/6	—
Yorkshire Hards	14/6 to 16/6	—
Derbyshire Hards	15/– to 17/–	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/– to 7/–	—
Smalls	3/– to 4/6	—
Blast-furnace Coke (Inland)	12/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		18/– to 19/–

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/– to 20/–
Second Smokeless Large	18/6 to 19/–
Best Dry Large	18/6 to 19/–
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	17/9 to 18/–
Western Valley Large	17/6 to 17/9
Best Eastern Valley Large	17/– to 17/6
Ordinary Eastern Valley Large	16/9 to 17/–
Best Steam Smalls	12/6 to 13/–
Ordinary Smalls	11/– to 12/6
Washed Nuts	18/– to 21/–
No. 3 Rhondda Large	19/6 to 20/–
,, ,, Smalls	15/6 to 16/6
No. 2 ,, Large	16/3 to 16/9
,, ,, Through	15/– to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	30/– to 37/6
Furnace Coke (export)	27/6 to 30/–
Patent Fuel	23/– to 24/6
Pitwood (ex ship)	27/9 to 28/–
Swansea—	
Anthracite Coals:	
Best Big Vein Large	34/– to 36/–
Seconds	27/6 to 30/–
Red Vein	23/– to 26/–
Machine-made Cobbles	36/6 to 40/6
Nuts	40/– to 45/–
Beans	26/– to 29/–
Peas	17/– to 19/–
Breaker Duff	8/6 to 9/–
Rubbly Culm	7/9 to 8/3
Steam Coals:	
Large	18/– to 19/–
Seconds	16/6 to 17/–
Smalls	10/6 to 12/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 7/6 joists and 5/– all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Maritime Exhibition.

The second annual Maritime Exhibition in Paris was held this year in the Grand Palais, and, with the demonstrations on the Seine, special efforts were made to enhance the popularity of these gatherings. Their object is to stimulate public interest in inland navigation, so that it may be possible to develop an industry which will serve as an outlet for builders of internal combustion engines. With her splendid system of inland waterways France offers every inducement for motor boating, but so far it has failed to become popular, nor does it appear likely to appeal to the French sufficiently to justify the belief that the efforts to develop the pastime will meet with any conspicuous measure of success. Along the coast the use of internal combustion engines has become almost general, particularly among the fishing fleets; but, on the rivers and canals, motor boating has made very little headway. The Exhibition, therefore, failed to convey an idea that the motor boat industry is in a flourishing condition. The only interesting feature was the number of gliders with air propellers, which appear to have been employed with success in the colonies, where navigation on very shallow rivers is rendered possible by this means and high speeds can be attained. Aeroplane firms like Farman and Voisin either build gliders or supply engines and mechanism for their construction, and some of them are now in service in Africa and in South America. It is stated that a Dumond-Galvin glider, with a Voisin engine, carrying thirty passengers, is running regularly over a distance of 800 miles on the Magdalena River in Colombia. As these gliding boats are propelled by powerful aero-engines the fuel consumption must be high. Some of the ideas in glider design are peculiar. The S. Koiransky flat-bottom shell is mounted on a number of articulated legs terminating in floats. When at rest the boat floats on the water and when in motion the legs are lowered so that the boat is above the water and skims on the floats. The boat, when in motion, has an uncanny appearance. Several types of aero-engines for gliders were shown, but there was nothing newer than what was seen at the Exhibition last year. Lorraine, for example, presented engines including a twelve-cylinder developing 500 horse-power. For such powers the reverse is effected by sliding gears. In reversing gears there was nothing new, except that Deutz and other foreign firms exhibited them with their engines. Apart from Burmeister and Wain, who exhibited engines and models, and the productions of the Chantiers de la Loire there was little to interest the motor shipbuilder, and this is characteristic of the way in which motor ship construction has been lagging behind in this country, although there is some indication that more activity will be displayed in this branch of shipbuilding at an early date. Renault showed the way to economical commercial motor boating by exhibiting a passenger boat equipped with an engine running on suction gas. This is probably the first time that a boat has been equipped with charcoal suction gas plant. There were a large number of detachable engines and propellers for fitting to the sterns of small boats, many of them of American manufacture. An exhibit was made by the Ministry of Marine. Although the Salon Nautique was not so comprehensive as had been expected, it is probable that no trouble will be spared in the future to give it a character which will awaken public interest in maritime matters and assist in the development of the motor boat industry.

The Steel Organisation.

It has been observed that all the difficulties encountered in the way of bringing about a complete organisation of the steel industry, whereby the production may be adjusted to the demand and price cutting will be avoided, have arisen from the attitude of Belgian firms. Until recently they did not display any outward opposition to the principle of an organised control of the industry, but whenever negotiations were instituted they either came to terms with great reluctance or refused to join forces with other continental producers. It was supposed that they were asking for more than they were entitled to, and concessions were offered to them, without result. It appears, however, that the Belgians are not holding out in the hope of getting better terms, but are really opposed to any organised restriction, for the reason principally that, being mainly an exporting country, Belgium cannot submit to the same conditions as other countries. Belgian makers argue that the working of the Steel Union has proved of particular benefit to the French, who have been receiving large sums which had to be paid by other countries for exceeding their allotted quota of production. Such payments, of course, helped to reduce the cost of French steel. The Belgians refuse to have their production reduced to 60 per cent., as they believe that they are quite capable of disposing of their maximum output, although that must necessarily entail a cutting of prices. There are rumours that the Belgians favour a withdrawal from all international combinations, including the Steel Union, and the possibility of their doing so is causing serious anxiety to the French. It is certain that there is not the slightest hope of the steel trade recovering under present conditions unless continental producers combine to prevent a collapse of selling prices which would prove ruinous to many firms. Already some of them are only able to keep going with difficulty. The French steel makers are endeavouring to induce the Belgians to see that their interest lies in a general organisation of the continental steel output, and until there is some definite assurance of a Belgian co-operation the situation is regarded as critical.

Automatic Couplings.

The Minister of Public Works, having opposed the introduction of a Bill requiring the railway companies to adopt automatic couplings on all vehicles, on the ground that the trials of the three French types of couplings are not yet completed and that their adoption can only follow the fitting of continuous brakes on goods trains, which cannot be effected within less than six years, the Commission of Finance has recommended that the date for the compulsory adoption of automatic couplings shall be postponed until 1938.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

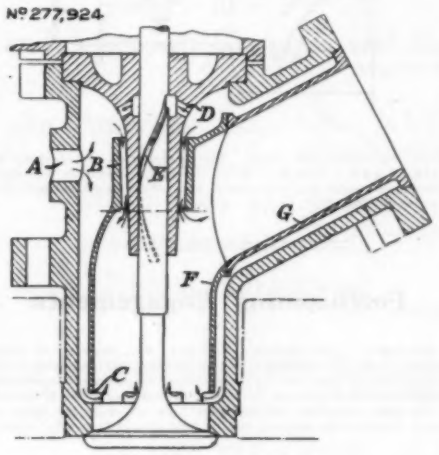
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

277,924. June 22nd, 1926.—Air Jacketed Exhaust Valves, R. W. Bailey, 23, Stockport-road, Altrincham, and the Metropolitan-Vickers Electrical Company, Ltd., 4, Central-buildings, Westminster.

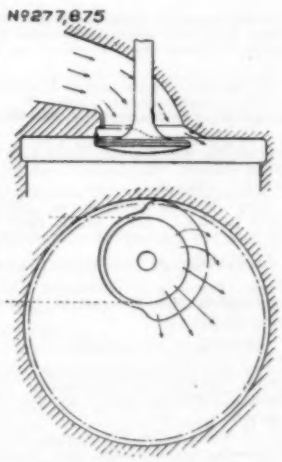
In this engine the exhaust valve is cooled by air, supplied by the scavenging pump, and is introduced at A. This air circulates round the internal jacket indicated at B, and escapes into the exhaust pipe by way of the ports C. Some of the cooling air



finds its way through the port D in the valve stem guide and down grooves E cut in the valve stem. It is noteworthy that the two parts of the internal wall of the jacket F and G communicate by means of a joint which allows of unequal expansion and contraction of the two parts. The heat contributed to the cooling air in its passage may be recovered in conjunction with that of the exhaust gases, or separately by isolating the circuit of the air.—*September 22nd*, 1927.

277,875. March 28th, 1927.—Valves of "Overhead Valve" Engines, H. R. Ricardo, 21, Suffolk-street, Pall Mall, London, S.W. 1.

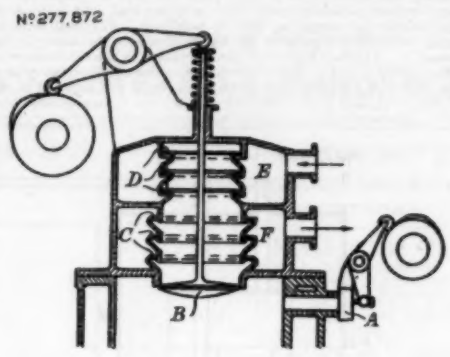
This invention aims at the development of a turbulent movement in the charge coming into the cylinder of an internal combustion engine. To this end, the valve is placed excentric to the bore of the cylinder, and the valve seat member or the part immediately adjacent to that in which the valve seat is formed,



is asymmetrical in shape, a portion being formed in such a manner that a preferential path is given to the entering air. On one side the valve seat is heavily masked, while on the side which lies in the direction towards which the turbulent flow is desired to rotate, this mask is more or less completely cut away. This cut-away portion may occupy more or less of one-half the circumference of the valve seat. The illustration shows plainly one method of carrying out the invention.—*September 29th*, 1927.

277,872. March 22nd, 1927.—Valve Gear, R. A. Furrer, Villa Skogheim, Fredrikstad, Glemmen, Norway.

This invention relates to the air inlet and exhaust valve arrangements for an internal combustion engine working on the four-stroke cycle principle, in which a single valve combines the functions of admitting air and exhausting with separate automatic air or exhaust valves worked by the suction or pressure in the engine cylinder. In the illustration the fuel valve A and the central combined air and exhaust valve B are worked by levers from separate cam shafts. Above the face of valve B is arranged a series of automatic ring valves C and D, which are housed in the separate chambers E and F. The direction of the entering air through the top valve is such as to cool all the valve parts. Other illustrations are given in the original specification, showing the combined valve offset from the centre of the cylinder, with the fuel valve in its usual central position. The automatic air inlet and exhaust valves may also be of the disc or ring type arranged as a series around an annular space, one above the other, as shown in the accompanying illustration,

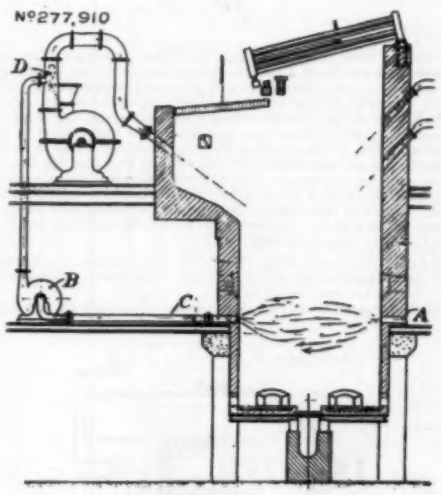


or one within the other, as is found to be most convenient.—*September 29th*, 1927.

FURNACES.

277,910. May 24th, 1927.—Pulverised Coal Furnaces, Société d'Electricité de la Region de Valenciennes-Anzin, 75, Boulevard Haussmann, Paris.

The inventors propose to cool the ashes falling down in a powdered fuel furnace by means of a stratum of cold air. This

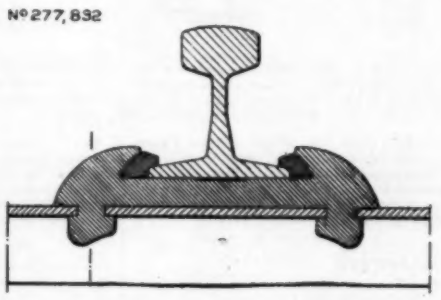


air is drawn in from the atmosphere through openings A by means of a fan B and pipe connections C on the opposite side of the furnace. The air in its passage across the furnace is heated to a temperature of from 400 deg. to 500 deg. Cent., and is introduced into the powdered fuel system at D.—*September 29th*, 1927.

TRAMWAYS AND RAILWAYS.

277,832. June 9th, 1927.—Railway Chairs, Guest, Keen and Nettlefolds, Ltd., Newport, Mon., and J. P. Bayley, Ty-Gwyn, 4, Westfield-road, Newport.

According to this invention the chairs or chair plates used in conjunction with metallic sleepers are formed by being cast on



to the sleepers and the cast metal is allowed to flow through holes punched through the sleeper, as shown in the illustration, to form a head. The lower face of the head is so shaped that the sleepers, when nested for transport, will fit snugly together.—*September 29th*, 1027.

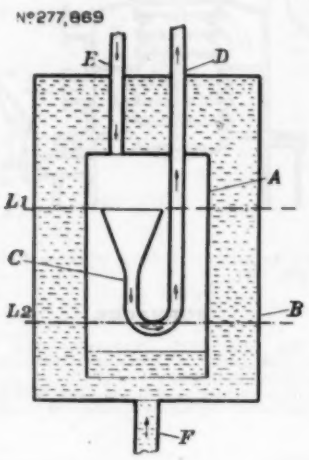
MISCELLANEOUS

277,869. March 16th, 1927.—Water Chlorinating Apparatus, B. Bramwell, 99, Bridge-end, Belfast.

The object of this invention is to provide a construction of apparatus for the chlorination of water which will give equal and positive displacements at varying speeds and prevent bubbling, so that the total number of oscillations is in direct proportion to the total volume of gas delivered by the apparatus. An apparatus embodying the invention is shown in vertical cross section in the accompanying drawing, in which *A* is the displacement vessel which is closed at the top and open at the bottom, and is contained in a closed water vessel B into which the water supply is led through a pipe F. Both A and B are made of transparent material, such as glass or celluloid, so that the rate of displacements or oscillations can be observed and regulated by the gas supply, which latter is led to the displacement vessel by a pipe E on which is fixed a regulating valve—not shown—to control the amount of gas admitted. The use of a U-tube C D inside the displacement vessel A and its arrangement and proportions constitute the important feature and

novelty of this invention. The upper end of the short leg of this U-tube C D inside the displacement vessel is of considerably larger diameter than the tube, the effect of which is that immediately the water rises a little past the top, a comparatively large volume overflows and forms a water seal, which prevents the further gas escape as well as bubbling. The seal remains until the further supply of gas again displaces the water in the vessel A. Another feature of the invention is the advantageous effect of the U-tube. This is arranged so that the bottom edge of the vessel A extends somewhat lower than the bottom of the U-tube C D, and gives sufficient time for the complete emptying

№ 277,869

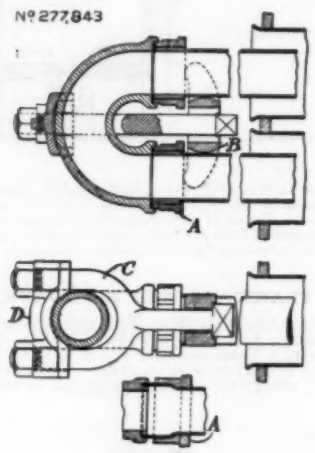


of the gas from A without any bubbling. Assuming that the water is at the level L_1 in the displacement vessel A, the gas entering the vessel through pipe E gradually depresses the water level in vessel A and simultaneously the water in the left or funnel leg C of the U-tube is displaced up the right leg D by the pressure of the entering gas, and when the water level in the left leg of the U-tube reaches level L_2 the U-tube seal is forced and the gas escapes freely through the leg D. The consequent sudden release of pressure within the displacement vessel permits the water in vessel A to rise again to level L_1 and re-establish the seal. It will be seen that at each pulsation a definite volume of water and a definite volume of gas escape through the leg D of the U-tube.—*September 29th*, 1927.

277,843. December 28th, 1926.—Superheaters, Galloways, Ltd., Manchester, and H. Pilling, Glenderwyn, Manchester-road, Choriton, Manchester.

In this superheater header connection the tubes are provided

№ 277,843

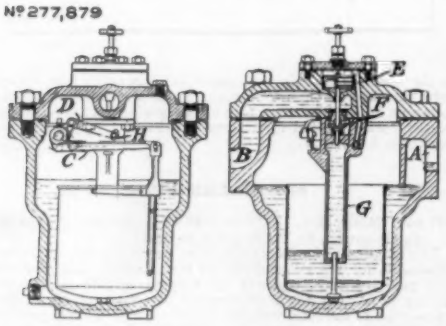


with collars A, which may be screwed on or bear against swellings on the tubes. These collars are engaged by yokes B, which are pulled up in place by forked bolts C and caps D bearing against the return end of the header.—*September 29th*, 1927.

277,879. April 7th, 1927.—Steam Traps, C. St. C. Plummer and W. M. Kermode, Soho Works, Allerton-road, Bradford.

This trap is of the open bucket type, and is shown in the illustrations in section in planes at right angles. The inlet is marked A and the discharge B. When the water contents of the casing overflow into the bucket, and it sinks, a lug on the lever C

№ 277,879

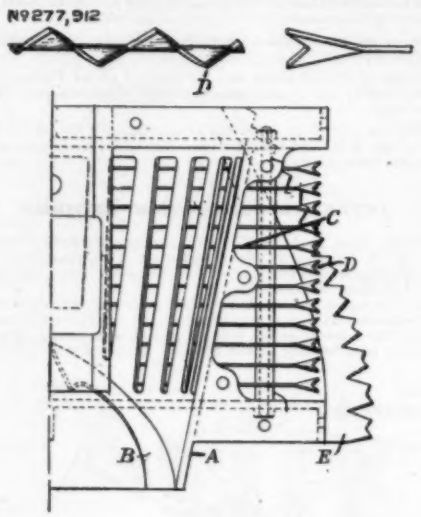


engages with another on the lever D and a pilot valve is opened which admits pressure to the piston E to open the outlet valve F, so that the internal pressure may discharge the water *vid* the pipe G. The pilot valve is held open until the bucket, on floating again, brings the two levers into contact at H.—*September 29th*, 1927.

277,912. June 9th, 1927.—Apparatus for Atomising Liquids, S. Wright, 6, Park-avenue, Timperley.

This atomiser is intended for use in connection with the scrubbing of gases. It is of the centrifugal type and comprises a hollow cone A, which is rotated at a high speed and dips into water at the bottom. The water is lifted by the spiral vanes B and escapes through slots in the cone. Outside the cone there is a number of closely spaced discs C, across which the water is

№ 277,912



driven by centrifugal force. The peripheries of the discs are provided with "beaters" D of the form shown in the detail sketch. Outside the discs there are other spiral beaters E.—*September 29th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "What is Wrong with Industrial England," introduced by Mr. F. Clements. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Annual general meeting. 7.30 p.m.

Keighley Association of Engineers.—Room 14, Temperance Institute, Keighley. Lecture, "Recent Developments in Special Steels," by Mr. S. A. Main. 7.30 p.m.

SATURDAY, NOVEMBER 12TH.

Institution of Municipal and County Engineers.—Town Hall, Chippenham. Southern District meeting. 12 noon.

MONDAY, NOVEMBER 14TH.

Bradford Engineering Society.—Technical College, Bradford. Lecture, "The V-Rope Drive," by Captain J. Dawson. 7.30 p.m.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Brassfoundry Practice," by Mr. A. Logan. 7.30 p.m.

Institute of Physics.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Lecture, "Physics in the Food Industry," by Sir William Hardy. 5.30 p.m.

Railway Club.—25, Tothill-street, London, S.W. 1. Paper, "London's First Railway—the London and Greenwich," by Mr. H. A. Vallance. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Alloy Steels, their Manufacture, Properties and Uses," by Professor H. C. H. Carpenter. 8 p.m.

MONDAY TO SATURDAY, NOVEMBER 14TH TO 19TH.

Public Works, Roads and Transport Exhibition and Congress.—Agricultural Hall, Islington, N. 1. For programme of Congress see page 520.

TUESDAY, NOVEMBER 15TH.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Joint meeting of Birmingham and Coventry Graduates. Debate, "That the Day of the Sleeve-Valve Engine is Over." 7.30 p.m.

Institution of Automobile Engineers: Wolverhampton Centre.—Engineering and Scientific Club, Queen-street, Wolverhampton. Lecture, "The Production of Sparks for Ignition." by Mr. C. H. Stephenson. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Paper, "Plastic Yield, Shrinkage and other Problems of Concrete and their Effect on Design," by Dr. Oscar Faber. 6 p.m.

Institution of Electrical Engineers: North-Western Branch.—Milton Hall, Manchester. Joint meeting with the North-Western Branch of the Institution of Mechanical Engineers. Paper, "The Application of Electricity in Warships," by Mr. W. McClelland. 7 p.m.

WEDNESDAY, NOVEMBER 16TH.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Students' meeting. Address by Mr. J. R. B. Griggs. 6.30 p.m.

Institution of Municipal and County Engineers.—35, Dawson-street, Dublin. Irish District meeting. 3.30 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, London, S.W. 7. Papers, "The Influence of Forests on Rainfall and Run-off," by Dr. C. E. P. Brooks; "The Secondary Depression on the Night of January 28th-29th, 1927," by Mr. C. K. M. Douglas; "The Circulation of the Atmosphere Over Melbourne," by Dr. E. Kidson. 5 p.m.

Society of Technical Engineers.—102, Belgrave-road, London, S.W. 1. Ordinary meeting. 7.30 p.m.

THURSDAY, NOVEMBER 17TH.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Discussion on "Annealing." 7 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Papers: "Motor Omnibus Design," by Mr. H. G. Dunn; and "Cellulose Finish for Omnibus Use," by Mr. F. B. Grant. 7.30 p.m.

Institution of Civil Engineers: Yorkshire Association.—Hotel Metropole, Leeds. Paper, "Permanent Way Design on British Railways," by Mr. W. Hepworth. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Apparatus Standards of Telephonic Transmission, and the Technique of Testing Microphones and Receivers," by Captain B. S. Cohen. 6 p.m.

Institution of Mechanical Engineers: North-Western Branch.—The Engineers' Club, Manchester. Thomas Hawksley Lecture, "Application of X-rays to the Study of the Crystalline Structure of Materials," by Sir William Bragg, F.R.S. 7.15 p.m.

Institution of Structural Engineers: Yorkshire Branch.—Great Northern Hotel, Leeds. Paper, "The Bulking of Fine Grits Applied to Concrete Making," by Mr. J. E. Worsdale. 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—The Mining Institute, Newcastle-upon-Tyne. Paper, "The Application of High Pressures to the Reciprocating Marine Steam Engine," by Mr. S. G. Visker. 6 p.m.

THURSDAY TO SATURDAY, NOVEMBER 17TH TO 26TH.

International Commercial Motor Transport Exhibition.—Olympia, London, W. 14. 10 a.m. each day.

FRIDAY, NOVEMBER 18TH.

Chemical Engineering Group.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Some Modern Methods of Recovery of Lubricating Oils," by Mr. A. J. Broughall. 8 p.m.

Institution of Locomotive Engineers: North-East Centre.—Hotel Metropole, Leeds. Paper, "Locomotive Engine Failures, with Some Hints for their Prevention," by Mr. H. J. Stephenson. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Paper, "Modern Portland Cement Plant," by Mr. Hal Gutteridge. 6 p.m.

Junior Institution of Engineers.—Caxton Hall, Westminster, London, S.W. 1. Presidential address, "The Nile and the Use of its Waters," by Sir Murdoch Macdonald. 7.30 p.m.

TUESDAY, NOVEMBER 22ND.

Institution of Automobile Engineers.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Joint meeting with the Institute of Transport. Paper, "Military Transport Vehicles: Recent Developments and their Commercial Significance," by Captain C. H. Kuhne. 8 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Paper, "The Uses of Nickel Deposits for Engineering Purposes," by Mr. C. H. Faris. 7.30 p.m.

WEDNESDAY AND THURSDAY, NOVEMBER 23RD AND 24TH.

Institute of Fuel.—Institution of Electrical Engineers Savoy-place, Victoria Embankment, London, W.C. 2. Annual meeting. 10.30 a.m. each day.

FRIDAY, NOVEMBER 25TH.

Diesel Engine Users Association.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Centrifugal Castings for Diesel Engines," by Mr. J. E. Hurst.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Elutriation as an Aid to Engineering Inspection," by Mr. L. Andrews. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "A Talk about Pioneers in High-Pressure Steam," by Mr. Loftus P. Perkins. 7.30 p.m.

TUESDAY, NOVEMBER 29TH.

Institute of Metals: Birmingham Local Section.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Corrosion," by Dr. G. D. Bengough. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Blackstone and Co., Ltd., of Stamford, ask us to announce that they have opened a new branch in Glasgow, at Baltic Chambers, 50, Wellington-street, and have appointed Mr. W. Guthrie as their Scottish manager.

Newcastle-upon-Tyne Electric Supply Company, Ltd., asks us to announce that the electrical section of its construction department, formerly situated at 1, Saville-place, Newcastle-upon-Tyne, has been removed to the company's new offices, Carliol House, New Market-street, Newcastle-upon-Tyne, and it requests that all correspondence for that section should be sent to the new address.

Garrard Gears, Ltd., of Oxgate-lane, Cricklewood, London, N.W. 2, asks us to announce that arrangements are being made to form a company to be called Garrard Gears (Manufacture and Sale), Ltd., which will be entirely separate from Garrard Gears, Ltd., and to request that any communications with regard to the manufacture and sale for the United Kingdom should for the present be addressed to Mr. C. G. Garrard, at No. 76, Crouch-hill, N. 8. After the 15th inst. the registered address of this company will be Aerial House, The Hyde, Hendon, London, N.W. 9.

Swindon Excursions.—On Thursday of last week the Great Western Railway Company ran special restaurant trains to Swindon with passengers who desired to see the railway works. About 700 persons took advantage of the opportunity offered, and on arrival at Swindon guides were in attendance and took under their wing parties of twenty, whom they conducted over the selected route. The educational value of such a tour cannot be over estimated, and we hope to see other tours arranged by the Great Western and other companies. Space will not permit us to follow the tour in detail, but we may refer to the locomotive testing plant, which had a locomotive under test at the time of the visit. This plant was fully described in The Engineer of December 22nd, 1905. A set of machines which attracted a large amount of interest were the locomotive wheel-balancing machines, of which we had an illustrated description in our issue of April 2nd, 1920. Many other items of interest were seen and described by the guides. Although the trains were treated as special excursions, they were run at a speed of over 60 miles an hour.